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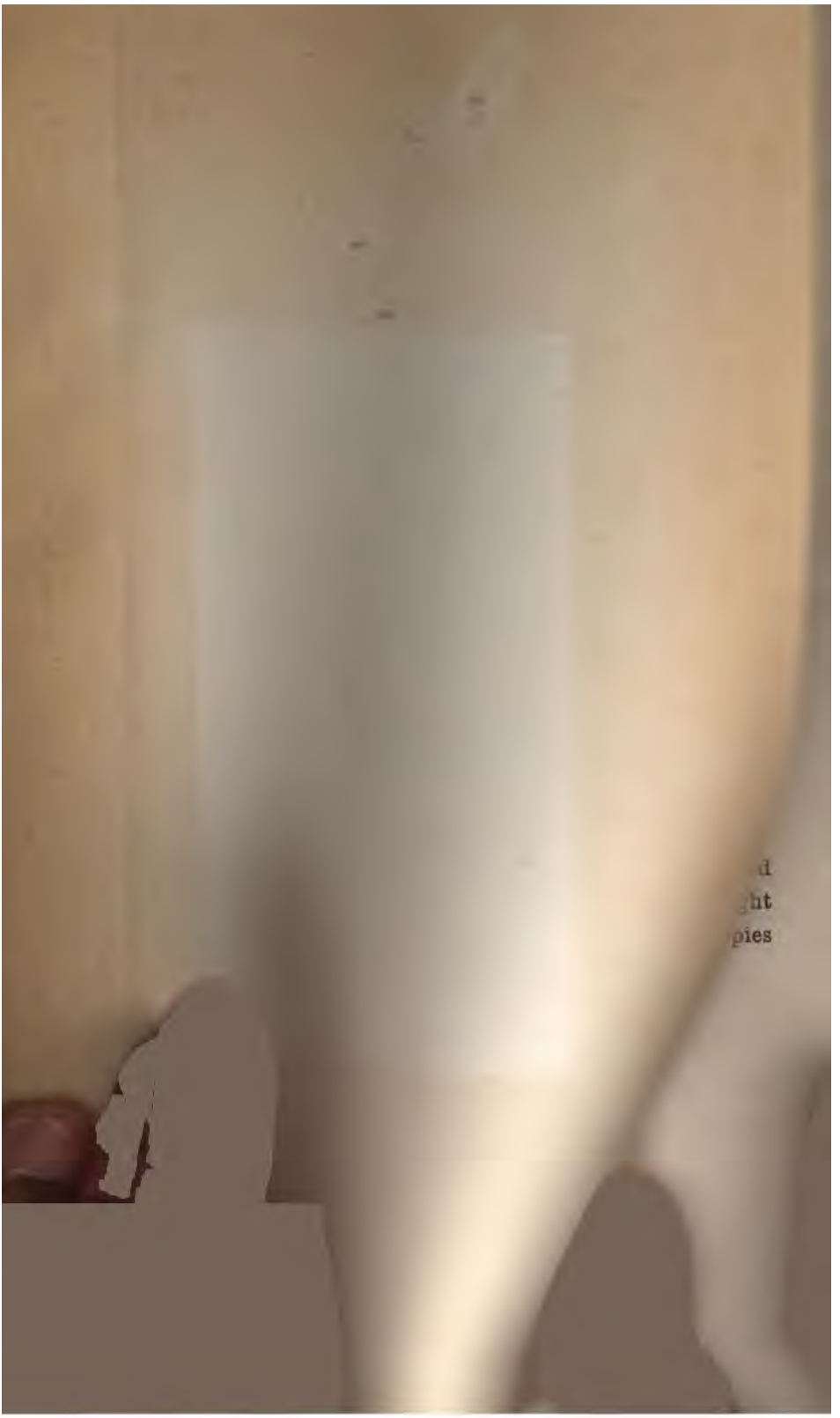

Part B

BULLETIN No. 1

RELATING TO

Safety and Efficiency in Mines

APRIL, 1916

Issued by the
Industrial Accident Commission
of the
State of California

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INDUSTRIAL ACCIDENT COMMISSION
OF THE STATE OF CALIFORNIA

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA.

Department of Safety—Mining Division.

BULLETIN NO. 1.

RELATING TO SAFETY AND EFFICIENCY IN MINES,

By EDWIN HIGGINS.

FOREWORD

It is proposed to send out from time to time, to the operators of mines in California, bulletins containing suggestions relating to safety and efficiency in mining. There will be included in each issue a list of drawings of various devices, copies of which may be obtained free of cost on request to the Chief Mine Inspector. Each bulletin will contain a discussion of the causes and prevention of accidents in connection with some particular phase of mining. The operators of mines are invited to take part in the discussion of any subject in which they are especially interested, to send in any discussion that they feel would be of interest to others, and to ask any questions concerning mine safety that they might wish to have answered. They may feel free to ask for copies of any of the drawings that are listed.

ACCIDENTS DUE TO FALLS OF ROCK AND ORE

More miners are killed from falls of rock and ore than from any other cause. The prevention of accidents of this nature is a matter which depends almost entirely on knowledge of the nature of the ground and the exercise of care, chiefly by the miner but also by the mine official. There are practically no mechanical safety appliances designed to prevent such accidents, unless timber may be considered as a safety device. Herein lies the great difference from other classes of mine accidents, for the prevention of nearly all of which there are provided numerous and varied types of safety devices.

The causes of accidents from falls

Many pages could be written bearing upon causes of accidents from falls of rock and ore. This is on account of the almost infinite variety in the classes of metalliferous deposits, which may occur in veins, beds, masses, chutes or irregular pockets; furthermore, these deposits may be flat or vertical or may lie at any angle between these two extremes. They may be made up of all gradations from the hardest rock down to material of the consistency of mud. Some classes of ore deposits are found at or near the surface; others extend a mile or more underground. Lack of space prohibits a full discussion of this phase of the subject. It appears sufficient for the present purpose to point out that in practically all cases accidents from falls are due to one or more of the following causes:

1. Mining large areas underground without the use of timber.

2. Failure to trim or pick down loose rock or ore from working places.

3. Improper timbering, including the use of too little timber, or the use of timber that is too small or not strong enough; also improper spacing, placing, blocking and lagging.

4. Delay in placing necessary timber.

Whatever the direct cause may be, the accident is usually traceable to *lack of knowledge of the nature of the ground, lack of knowledge of proper timbering,* or *carelessness.* As

to whether the operator or miner is chiefly to blame is a matter that is subject to wide discussion. Many writers claim that the greatest number of these accidents are due to the carelessness of the miner, or his failure to abide by rules and regulations. Certain it is that a certain amount of responsibility rests on the miner and on the operator, or mine official.

Responsibility of the operator or mine official

There are certain things that the operator or mine official can do to prevent accidents of this nature. His first responsibility is in the selection of a safe and efficient method of mining. There have been many instances where an excess of accidents from falls has been traced to a method of mining unsuited to the ore body. In several such cases within the knowledge of the writer certain modifications have resulted in decreasing the number of accidents and increasing the yield of ore per man employed.

The organization of the working force should provide for ample inspection of working places. The work of inspection usually falls to the lot of the foreman or shift boss and a great responsibility rests on him. Any laxity on his part, either in observation or in enforcing instructions given, may result in injury or death to the men working under him. In this connection it might be mentioned that in a certain large mine in Michigan a careful study of underground accidents revealed the fact that most of them were from falls of rock and ore, and that such falls were occurring in places thought to be safe. In the dangerous places extreme care was taken and there were few accidents. This particular company redoubled its inspection and provided more timber, especially in places where there was any doubt as to the nature of the ground, and in this way reduced the number of accidents from falls 50 per cent in six months' time.

Another responsibility of the management is to supply sufficient timber to the miner and to supply it promptly when needed. Many accidents are traceable to the fact that timber was not on hand when required.

Responsibility of the miner

While this bulletin is intended for the attention of mine operators and officials, it has been thought advisable to set forth some of the things that the miner should or should not

do, with the hope that some method may be used to convey the information to the miner. One of the first things with which a miner should familiarize himself is the nature of the ground in which he is working. He can not take care of himself underground unless he knows this and, further, knows the proper method of bracing the ground. Where the men are green there is all the more reason for careful inspection and instruction from the shift boss or foreman.

Miners should be impressed with the following precautions:

Always pick down loose pieces of rock or ore before starting work at the face.

Stand to one side or back under the timber when pulling or picking down a *loose back.*

Do not mine too much ore without considering whether or not timber is needed.

Place timber properly. If not sure it is right ask the foreman or shift boss.

Report strained or broken timbers *promptly.*

Never stand under a loose back.

Do not sit or stand under broken timbers or bad ground.

Do not take a short cut through dangerous workings.

When the boss tells you that you are doing something dangerous, stop doing it. He knows—*that is why he is the boss.*

There are many other admonitions that could be added to the above. If these suggestions can be impressed on the miner through the bosses, or by any other means, it is believed that many accidents from falls can be prevented.

MINE FIRES

On account of the recent occurrence of two very serious metal mine fires it has been thought that a few words on this subject might be of interest. This subject is of added interest to California mine operators at this time in view of the requirement of the Mine Safety Rules (Sec. 5) relating to oxygen breathing apparatus.

The first of the fires referred to started on January 8, 1916, on the forty-first level of Conglomerate Shaft No. 5, of the Calumet and Hecla Mine, at Calumet, Michigan. All of the miners were safely hoisted to surface, there being no loss of life. This fire was fought from January 8th to the 27th,

during which time crews of men wearing oxygen breathing apparatus, working in continuous shifts, succeeded in sealing off the fire by building concrete bulkheads. The cause of this fire is unknown, but the results serve to indicate the great value of breathing apparatus in preventing property loss.

The other fire referred to was that which occurred at the Pennsylvania shaft of the Anaconda Mine at Butte, Montana, on February 14, 1916. This fire was discovered at 9 o'clock at night by a station tender on the 1,200 level, very near the shaft station. In a very few moments the entire mine was filled with poisonous gases and it was with great difficulty that 200 of the miners were hoisted to the surface in safety. Twenty-one men lost their lives. Two of these were rescuers who overworked themselves in heroic efforts to aid their fellow workmen.

Technical Paper 17,* "Fires in Lake Superior Iron Mines," published by the United States Bureau of Mines, contains a discussion of 31 fires that have occurred in late years in the Lake Superior district. It is set forth that 14 of these fires were probably due directly or indirectly to the use of candles, and 19 of them started in or within a few feet of the shaft. They occurred in both wet and dry mines and in those that contained little timber as well as in heavily timbered mines.

The following paragraphs from this paper, regarding the cause and prevention of metal mine fires, and the gases generated by them, are of interest.

Principal causes of metal mine fires

The following may be set forth as the principal causes of metal mine fires:

Careless use of candles or miners' lamps.
Falling of candle snuff or leaving the same on timber.
Defective electric wiring.
Spontaneous combustion from friction in shaft rollers or underground machinery.
Spontaneous ignition of combustible rock.
Dropping lighted paper in ore chute.
Building small fires underground for any purpose.

*By Edwin Higgins.

Dumping ashes in open pits connected with underground workings.

Careless use of matches.

Smoking in timbered places near shaft collar or underground.

Sparks from surface engines of any kind or from surface fires.

Fire prevention

In adopting measures for the prevention of underground fires the aim should be to remove, as far as conditions will permit, the causes of fires and to provide means for quickly subduing an incipient blaze.

Statistics of metal-mine fires from all over the world show that the great majority of fires originate in the shaft or pump station, in the shaft proper, or at or near the shaft collar. Hence, it appears that fire prevention is of greatest importance in these places.

Summary of preventive measures

Do not use candles for lighting underground.

As far as possible, do away with timber construction in head frame, shaft collar, shaft, shaft station, and pump house.

Keep shaft rollers and other machinery well oiled.

Break continuity of timbering from pump house to shaft.

Dry, timbered shafts should be kept moist.

Do not allow combustible rubbish to collect underground.

Beginning at the shaft collar, do not allow smoking in any timbered place.

Make rules and enforce them.

Use care in electric wiring and guard against short circuiting by frequent inspection.

Do not use kerosene in lanterns or torches—if it is necessary to have them, use a heavy oil.

Do not allow the building of fires underground for heating.

Cover steam pipes laid near timber.

Do not store lubricating or illuminating oils in great quantity underground, especially in timbered places.

Fire-fighting

Below are suggested protective measures applicable to practically all mines. Although they may not all be necessary for any one mine, the list is suggestive and from it an effective system of fire protection may be worked out.

Provide one or more water plugs, with several lengths of hose, at or near the shaft collar.

Provide one or more chemical fire extinguishers at or near the shaft collar, at every shaft station, and in dry timbered drifts distant from the shaft.

Provide a water plug with hose at every shaft station, and supply water either through a separate line from the surface or by tapping the water column. A shaft-sprinkling device may serve the same purpose.

Make the air line convertible into a water line.

Have a water barrel and buckets at stations even when there are hydrants and hose.

Provide dry extinguishers, such as sand, salt, or powdered limestone.

Provide at stations of working levels a box containing tools for carpenter and pipe work.

Arrange for the control of ventilation through the use of doors.

It is desirable to install reversible fans to insure a positive movement of air in fighting fires.

Provide air-tight fire doors for the isolation of parts of the mine.

Install fire doors in each level if possible; also have fire doors at the top of the shaft if the shaft house is combustible.

Have fire drills and a prearranged plan of action in case of fire.

Provide oxygen-breathing apparatus.

Provide fire signals.

Arrange to notify men and to get them to the surface promptly in case of a fire underground.

Do not throw water down a burning upcast shaft when there are men below and the ventilation is only natural; the current is liable to be reversed and the smoke and gases thus sent into the mine.

In providing a water supply for fighting fire it is far preferable to run a separate pipe line into the mine from the

surface. Tapping the water column is less expensive, but this arrangement makes the supply dependent on the pumps. A barrel filled with water, with buckets near by, is an efficient protective measure in dry stations. This should be used especially where there is no provision for water from the water column or a separate pipe line; even when such provision is made, the barrel is useful as an auxiliary in case something goes wrong. In cases of underground fires men have been known to pass by chemical extinguishers to look for water, probably because they did not understand the extinguishers. Chemical extinguishers are excellent for quick work, but if they are installed it is important that sufficient men be instructed in their use. Also, the extinguishers should be kept properly charged.

Gases encountered in mine fires

In practically all metal mines the only gases that must be dealt with during a mine fire are carbon dioxide (CO_2) and carbon monoxide (CO). The exception to this is in the burning of sulphide ores.

Carbon dioxide (CO_2), or carbonic-acid gas, is a product of complete combustion and must be dealt with in all mine fires. It is a colorless gas without odor, but with a slightly acid taste. Its specific gravity (air = 1) is 1.529 at ordinary temperatures, but when highly heated it is expanded so that it may be lighter than cold air. It is produced by the burning of lamps, timber, or coal, by the breathing of men or animals, by the firing of explosives, and by the decay of timber or other vegetable matter.

The gas is seldom encountered in mine fires in sufficient quantity to cause poisoning, its effect being rather to replace the oxygen to such a degree that not enough oxygen is left to support life. Its first effect is to produce headache and dizziness and, in larger quantities, extreme panting. Air containing about 10 per cent of this gas will produce death in lengths of time depending upon the vitality of the subject. A candle will usually go out when the carbon dioxide content of the surrounding air reaches about 3 per cent. The candle goes out not because of the presence of the carbon dioxide, but because of the lack of oxygen. Experiments have shown that a candle also goes out in air containing between 16 and 17 per cent oxygen.

Carbon monoxide (CO), even in very small quantities, is much more deadly than carbon dioxide. It is a product of the explosion of "powder" or of the incomplete combustion of wood or other combustible material. It is more likely to occur during a smoldering fire, such as might result in a damp or wet mine. Carbon monoxide is colorless and tasteless, and has a specific gravity of 0.969. It acts as a poison to the human system by combining with the hæmoglobin of the blood and thus preventing that agent from absorbing the oxygen necessary to support life. One-tenth of 1 per cent of this gas, if breathed for a sufficient length of time, will render a human being unconscious and probably produce death. Larger proportions will produce death in relatively shorter periods of time. The gas can not be detected by the use of a candle, an important point, for many miners believe that wherever a candle will burn they can live. Its presence can be accurately determined only by a chemical analysis of the air. However, during mine fires, mice and birds, preferably canaries, may be used with advantage in determining the presence of carbon monoxide, as these animals succumb more quickly than a human being. The exhaust of gasoline engines contains large quantities of carbon monoxide.

LIST OF SKETCHES OF SAFETY DEVICES

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California mine operators. In asking for any of the drawings, they may be referred to by number.

No.

1—Arm and Leg Splints.
2—Electric Pull Switch for Mine Bell Signal.
3—Safety Hook for Bucket.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
7—Details of Safety Clutch for Cage.
8—Detail sketch of Safety Catch for Cage.
9—Safety Catch for Cage.
10—Miscellaneous Parts of Cage.
11—Shaft Cover for Sinking.
12—Safety Crosshead for Bucket.
13—Iron Drill Rack.
14—Lock Hook for Bucket.
15—Grid Iron for Protection at Collar of Ore Chute.
16—Iron Door.
17—Alarm Bell for Cage.
18—Standard Shaft Gate (Swing).
19—Safety Crosshead.
20—Removable Bonnet for Skip.
21—Cover for Skip.
22—Underground Dry Closet.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
26—Semiautomatic Gate for Mine Shafts.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
31—Gate for Shaft Collar.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
35—Cage Safety Catch Testing Device.
36—Safety Cage for Ladders.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
39—Cabinet and Rack for Mine Rescue Apparatus.
40—Change House.
41—Guard for Rip Saw.
42—Riley Two Deck Cage.

43—Automatic Side Dump Car.
- (a) Standard Incline Trip.
- (b) Draw Bar.
- (c) Lower Hinge of Dumping Mechanism.
- (d) Door Catch Angles.
- (e) Side View, Side Dump Car.
- (f) Details.
- (g) Details.
- (h) Details.
- (i) Details.
- (j) Details.

44—Underground Dry Closet.
45—Guard for Tram Car.
46—Underground Latrine.
47—Door for Cage.
48—Safety Crosshead.
49—Shaft Gate.
50—Trolley Support Methods.
51—Underground Toilet Car.
52—Sanitary Dry Closet.
53—Candle Holder for Miners.
54—Toboggan Stretcher for Underground Use.
55—Circular Removable Bonnet for Skips.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

Air Compressor Cooling with Water Barrels (Illus.).
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Drifting with a Stoper (Illus.).
Improved Safety Door for Dumps (Illus.).
Bucket-Dumping Device (Illus.).
Regarding Primers and Misfires.
Device to Aid in Fuse Spitting (Illus.).
Proper Way to Spit Fuses (Illus.).
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Burning Empty Dynamite Cases.
A Fire-Bucket Float (Illus.).
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
Automatic Landing Chairs (Illus.).
Spillage and Sinking Pocket (Illus.).
Crossheads for Bucket Hoisting (Illus.).
Runaway Tubs or Hutches (Illus.). A safety hook for shafts of slight inclination.
How to Splice Wire Rope (Illus.).
Miners' Dwellings (Illus.).
Concrete-block Mine Houses (Short).
A Simple Chain Ladder (Short).
Wood versus Steel Mine Ladders (Illus.).
Capital Mine Steel Ladders (Illus.).

A Simple, Strong Chute (Illus.).
A Substantial Ore Chute (Illus.).
Types of Chutes and Chute Gates (Illus.).
Removable Chute Spray (Illus.).
Drinking Fountain for a Mine (Illus.).
Water Disinfecting Outfit for Field Use (Illus.).
Septic Tank for Underground Latrine (Illus.).
Four-deck Shaft-repair Cage (Illus.).
Cover for Shaft Ladderway (Illus.).
Simple Folding Shaft Gate (Illus.).
Hinge for Shaft Doors (Illus.).
Shaft Timbering and Headgear on the Mesabi Range (Illus.).
Light Shaft Timbering (Illus.).
Locked Signal System (Illus.).
Bell-wire Arrangement in Sinking (Illus.).
Gravity Release Electric Signal Box (Illus.)
Warning Bell for Topman (Illus.).
Raising a Gin Pole (Illus.).
Straightening a Tall Leaning Chimney (Illus.).
Safety Staging Hook (Illus.).
Methods of Stope Timbering (Illus.).
Emergency Pipe Wrench (Illus.).
Timbering for Air-check Doors in Motor-haulage Drift (Illus.).
Ventilating a Long Drift.
Water-tank Indicating Gauge (Illus.).

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TO THE MINE FOREMAN

The best safety device is a careful man.

Greater safety stands for a saving in time, steadier work, greater efficiency, increased output and larger profits.

Make it your business to talk safety to the men, both individually and collectively.

Survey a job carefully and consider whether it is being done in the safest way.

See that safeguards are kept in place and that safety devices are used.

Stop dangerous practices wherever you can see them. Remember that two-thirds of all accidents are due to thoughtlessness, carelessness, and ignorance.

Keep the premises about your work orderly. See that proper light is provided.

Use accidents and near-accidents as a text, drawing lessons from them as to what not to do.

Watch for loose sleeves, flopping blouses and flying neckties —anything that may catch in machinery and draw men in.

Show your interest in your men and ask them for suggestions on how to make things safer.

(From "Safety First," Nevada Consolidated Copper Co., Vol. 3, No. 11)

BULLETIN No. 2

RELATING TO

Safety and Efficiency in Mines

MAY, 1916

Issued by the
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of the
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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA

DEPARTMENT OF SAFETY—MINING DIVISION.

BULLETIN NO. 2.

RELATING TO SAFETY AND EFFICIENCY IN MINES.

By EDWIN HIGGINS.

FOREWORD

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ORGANIZATION AND PROSECUTION OF SAFETY WORK

The fact that safety work pays is established by the records of many mining and other industrial companies of the United States. When the safety movement was in its infancy, it was necessary to set forth many arguments as to why it would prove advantageous to operators to make places of employment safe. That necessity no longer exists, for there are available on every hand reports which show that accidents can be prevented and that their prevention results in a direct financial gain. Investigation will convince the most skeptical that this is true. There is, of course, no argument as to the desirability, from a humanitarian standpoint, of safe working conditions. No employer has any desire to injure his workmen; nor do workmen wish to receive injuries.

When a man is injured at his work the chances are that this particular piece of work must cease, or at least be delayed. It may be necessary to replace the injured man by one who is inexperienced or unfamiliar with the work in hand. In any event a certain amount of demoralization must result when a workman is injured. If he is killed, much loss of time results. Frequently such an incident seriously affects working conditions for several days. If the man who is killed is an old and experienced workman, the benefit of his years of experience at his particular line of work is lost. What is more important, a fatal or permanent injury might take away from a family a loved one and its only means of support. A study of injuries to workmen shows that the causes are often but the beginning of a series of events and conditions replete with suffering, misery, trouble and expense, affecting both the employee, the employer, and often the entire community.

Safety work serves to promote better relations between the employer and the employee which, in turn, results in a more earnest effort on the part of the workman in the prosecution of his duties. In cases where compensation is paid by the

employer, or insurance based on a merit rating system is carried, the prevention of accidents results in a direct financial gain. Regardless of the system of insurance, the reduction of accidents must eventually result in cheaper rates. The final proof of the desirability of having safe working places is the fact that safety work has grown enormously since its inception, until today it is being practiced generally, at the expense of many thousands of dollars, by mining and other corporations throughout the United States. In many localities safety work is a recognized factor in the cost of production.

Organization

The size of the safety organization necessary depends largely on the magnitude of the operation. In mines employing a limited number of men, say from 10 to 15, the necessary safety work can be carried on by the man in charge. Where 25 to 30 are employed the work can be satisfactorily handled by one or more men whose entire time is not taken up with other duties.

There are described below the safety organizations of four prominent mining companies in the United States. While these descriptions refer to extensive operations, they are suggestive for work of this kind on a smaller scale.

1. The mines covered by this organization are large and are all situated on one of the iron ranges of Michigan. The safety department is in charge of an inspector, and it is his duty to inspect all mines as frequently as possible and submit reports and recommendations to the manager. Periodical trips are made in and about the mines by a committee of mine foremen, consisting of three members, each of whom is selected from a different mine. The inspector accompanies this committee and incorporates its recommendations in a report. Another committee, having similar duties, is made up of workmen. The activities of this committee, however, are limited to the mine from which it is selected. The members are changed after each inspection, so that in time all employees are given a chance to criticize conditions in and about the mine.

All accident reports and safety recommendations are considered by a committee of mine superintendents, the head mining captain, master mechanic, assistant auditor, secretary of the pension department, safety inspector, and the manager,

who acts as an ex officio member. This committee meets once a month and confirms or rejects safety recommendations.

In addition to the above committees, there is one more made up of three mine superintendents. This committee investigates all fatal accidents and makes a report thereon to the manager.

2. The following form of organization is employed by a company operating both large and small mines at various scattered points: The department is under an inspector, who, with the assistance of three experienced miners, inspects each mine of the company at least twice a week. After a mine is examined, a report, including any recommendations thought necessary, is sent to the safety inspector. The safety inspector in turn makes a weekly report to the superintendent, who looks after all recommendations having to do with upkeep. The safety inspector makes a monthly report in triplicate to the manager in which recommendations are submitted for approval. Such recommendations are made out to the head of the department concerned. When approved by the manager, one copy is returned to the safety inspector, to be kept by him until the indicated improvement is made. Two copies go to the superintendent, who keeps one and sends the other to the head of the department concerned. On the completion of the improvement, the head of the department sends the recommendation back to the superintendent, who then destroys his copy and sends the indorsement of completion to the safety inspector. The safety inspector destroys his record and files in its place the report showing that the improvement has been made. This report is in the form of a printed card with blank spaces filled in according to the needs.

All company bosses and first-aid men meet once every two months to discuss accidents that have occurred during the previous two months. Safety, sanitation, first aid, and welfare work are also discussed at these meetings.

3. A similar organization to that described above is maintained by a company operating small groups of mines at scattered points. A chief inspector is in charge of the safety work at all the mines. The foreman's safety committee, consisting of four foremen from the mines of a certain district, works directly under the chief inspector. This committee makes a trip every three months through all mines of the district. Its personnel is changed after each inspection trip. The

committee reports to the inspector, who, in turn, includes this report in his recommendations to the superintendent; a copy of the report also goes to the general manager.

4. This organization operates in connection with one large mine. Inasmuch as the organization was changed after the safety work was well under way, it may be well to point out the various steps in perfecting the organization. An engineer was placed in charge of a department of efficiency and safety. He first made a thorough study of conditions in the mine and determined the principal causes of injury to the men employed. Finding that the greatest number of accidents occurred from falls of rock and ore, and from men falling down unprotected places in the mine, timber inspection was doubled and every place in the mine where it was thought that there was a possible chance for a fall to occur was timbered. All open places were protected by means of doors or gates. This movement effected an immediate and marked falling off in the number of accidents from the causes mentioned.

Finally, three assistants were added to the department and each one of them was given a certain feature of the work to look after. This was necessary on account of the magnitude of the operation. The safety and efficiency work then developed into daily inspection trips by all the members of the department. Reports were made by them to the head of the department, who considered recommendations made and obtained immediate action thereon through consultation with the manager. Lately these daily inspection trips have been abandoned; the members of the organization now average two or three trips a week through the mine.

Daily meetings, attended by the manager, superintendent, head of the efficiency and safety department, and mine captains, are held. Here all matters pertaining to efficiency and safety are discussed. As these meetings are held in the morning, it is possible to hear the reports of the shift bosses to the mine captain. In this way daily happenings and conditions in the mine receive prompt attention.

The Safety Campaign

One of the first things to be done in outlining a safety campaign is to make a careful study of the accident records of the mine. Steps should be taken to provide such devices

and methods as will tend to decrease the most common classes of accidents. These will usually be found to consist of accidents from falls of rock, falling into open places, haulage accidents, and accidents caused by the handling of explosives. Careful study of the method of mining and timbering should be made with a view to making any changes that will lead to greater efficiency and safety. Every detail of mining should be gone over carefully, and unsafe practices eliminated. Dangerous open places should be protected, exposed moving parts of machinery covered, and fire protection provided where necessary. A system of inspection should be worked out in order to insure that the workmen are doing their part to prevent accidents. Rules and regulations should be drawn up and printed. If necessary, these should be printed in various foreign languages, as well as in English.

After the safety work is organized, by far the most important work to be done is to secure the co-operation of the miner. Without this co-operation the most efficient organization is doomed to utter failure. Many safety experts claim that this feature of safety work is from 80 to 90 per cent of the entire problem. There are outlined below some of those methods which, in conjunction with such original ideas as may be brought into use, have proved most valuable in securing the co-operation desired.

Bonuses for Safety Work. In the prosecution of safety work there is probably no one idea that has been productive of better results than the payment to shift bosses or foremen of a cash bonus for the reduction of accidents. In studying results of many mining companies I have yet to find one that has not achieved remarkable results from this plan. No set rule can be laid down for the carrying out of this scheme, for all organizations are not alike, and it is very important that the system be worked out to fit conditions existing in a given mine. Various companies offer a prize of from $25 to $100 in cash to the shift boss who turns in the best record for safety over periods of time varying from three months to a year. To my knowledge, one large company reduced its accidents 400 per cent in one year, and the claim was made that it was due almost entirely to a system of bonuses paid to bosses. A bonus of even $5 or $10 per month will be found to give good

results. Great care should be observed in working out the bonus system, for dissatisfaction may result if it is not equitable.

Pay for Safety Suggestions. Many companies have obtained good results by offering to pay $1 or more for every safety suggestion offered by an employee, provided the suggestion is accepted and put into use. This stimulates the interest of the men in the work and ofttimes brings out valuable information.

First Aid Training. The training of men in first-aid-to-the-injured has a double effect. While fitting men to take care of themselves or a fellow workman in case of injury, it gives them an insight into the result of injuries and makes them more careful in their work. Statistics of several large companies show that the men who have received first aid training are far less prone to receive injuries than men who have not been so trained.

Bulletin Boards. The use of a bulletin board for the posting of accident records, notices of various kinds, accounts of accidents, etc., are invaluable. Interest and rivalry may be stirred up by posting comparative records of the various bosses.

It should be remembered that the campaign to secure the co-operation of the miner is the most important part of the work and that nothing should be left undone to keep the idea of safety continually before him. Ingenuity ofttimes can be displayed in devising ways and means for doing this. Smokers, at which interesting talks, music, something to eat and smoke, and other entertainment are offered, do much to promote a better feeling and to keep the safety subject uppermost.

Cost of Safety Work

There is, of course, a limit to the amount of money that can be expended effectively on safety work. Doubtless it is best to make a modest beginning, increasing the scope of the work and the financial expenditure as information is gained as to the best procedure. I had occasion recently to secure figures relative to the cost of safety work from 17 mining companies. The number of men employed ranged from 38 to as high as 2,178 men per day, the total number of employees of the 17 companies being 5,480. The amounts expended yearly for safety work ranged from $230 up to $15,000. The total amount expended yearly was $55,356. Figured out on the basis of

the amount expended yearly for each man employed, the range was from $1 to as high as $48. The average for the 17 companies was $10.10 per man per year. That average was much higher than it should have been, as the companies considered included many that were just beginning their safety work. One company, employing over 2,000 men, and having a well organized and efficient safety system, spent approximately $6 per year per man employed. It is probable that a fair average for maintaining safety work, after the preliminary work has been done, would be in the neighborhood of $5 per year per man employed. This does not mean that effective work can not be done for less than this amount. Some companies that are only spending $1 per year per man are getting good results.

Ten men were killed in California mines during the first four months of 1916. It is gratifying to note that this is less than the number killed during the first quarter of 1915. The purpose of our safety work is to prevent a continuation of this high rate of fatalities.

The following statement and table, comparing accidents in 1914 and 1915, are taken from a report recently issued by the Safety Department of the Copper Queen Consolidated Mining Company, Bisbee, Arizona:

"The Safety Department has been in operation for a period of two years and five months, long enough that a thorough comparison may be made between former methods and the present one of organized welfare work, in which the company, its officials and employees co-operate in the work of preventing accidents, in the training of men in first aid to the injured, the use of oxygen rescue apparatus, and work together for the general good."

"The report of this department for the year 1915 should convince the most skeptical that organized welfare work is good business for the employee, the company and the community."

Record of Injuries during 1915, Copper Queen Consolidated Mining Company.

	Fatal	Permanent	Serious		Minor	No loss of time	Total
			14 days	20 days (or more)			
1914 ------	7	2	229	121	1,322	879	2,329
1915 ------	2	2	119	86	835	766	1,724
Reduction	5	0	110	35	487	113	605
Per cent	71	0	48	29	37	13	26

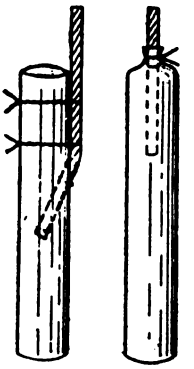
ACCIDENTS FROM MISFIRES

Of the 10 fatal accidents reported in California mines during the first four months of 1916, three of them resulted from missed holes. In addition to these fatalities, several men were seriously injured. Such a large percentage of accidents from misfires is very unusual.

There are many things to be considered in the prevention of accidents of this nature. In the first place, it is necessary that powder, caps and fuse be of good quality. The storage and care of explosives have much to do with their action when put in use. They should not be stored in damp places, nor exposed to dampness after removal from the magazine. Fuse should be observed closely to see that it is not damaged. It should be freshly cut when put into the cap. Capping fuse more than 36 hours before using it is poor practice. All explosives should be used as soon as possible after removal from the magazine.

If the face to be blasted is very wet, it is important that holes be not loaded too great a length of time before blasting. In wet places care should be taken to protect the joint between the cap and fuse. The use of oil or grease for this purpose is very objectionable, for the burning fuse, coming in contact with such material, causes it to form a spray which may easily cause a misfire. Fuse manufacturers supply a satisfactory compound for water-proofing. Also, there is on the market a rubber covering for protecting the cap from moisture. Good roofing paint gives satisfactory results. Ordinary white laundry soap will water-proof a joint for a short period of time.

The making of the primer is a very important consideration. The United States Bureau of Mines has made many and extended tests to determine the best method of making primers. Without going into detail, it may be said these results showed that any method of making the primer necessitating the bending of the fuse at a sharp angle is very undesirable. The double lace, or placing the cap in the bottom of the cartridge and bending the fuse back through 180 degrees, are objectionable. The two methods that resulted in by far the minimum of misfires under all conditions are shown in the accompanying sketch.



Two methods of making a primer that gave the least number of misfires in Bureau of Mines tests.

The Handling of Missed Holes

After everything possible has been done to insure the proper detonation of the charge, the next matter of importance is to see that misfired holes are handled safely. This appears to be simple enough, but any method that may be devised brings into consideration the human element. There will always be men who, from time to time, will violate rules. Frequently an experienced man will take even greater chances than will a greenhorn. Men who have spent almost a lifetime handling powder have been killed as a result of misfires. In many cases familiarity with powder causes a man to regard danger lightly.

It is second nature to most miners to count the number of reports from a round of holes. It is at this point, however, that many misfire accidents originate. The miner either goes back to a missed hole too soon or he fails to report the misfire. If he does report it, there often develops some mistake in transmitting the information to the proper man on the next shift. The following plan has been found satisfactory in handling misfires: See that miners count the number of blasts and, if the entire round has not exploded, provide means so that a report can be made to the shift boss of the next oncoming shift as to the number and location of the missed holes. A record may be kept on a bulletin board either underground, or in the change house. Some companies provide printed forms and cause their miners to report misfires to the shift boss, who in turn delivers the printed report to the shift boss of the next oncoming shift.

Misfired holes should be handled under the supervision of the shift boss, or some one experienced in this class of work. To insure safety in recovering a missed hole, the following procedure should be observed: Under no circumstance should any one be allowed to return to the face within 45 minutes of a misfire. An attempt should first be made to fire the missed hole by means of a new primer. If this is not possible, or if it fails, a new hole should be drilled at least two feet from the missed hole in such a direction that it will not encounter the defective charge in the old hole.

The only method of insuring compliance with requirements laid down for the proper handling of missed holes is to use the strictest discipline in every case of disobedience to rules. No matter how valuable a miner may be, he is a menace to himself and those working with him, if he will not use care in the handling of missed holes.

The above short discussion relates chiefly to the prevention and safe handling of misfires. For information on the general subject of storing and handling explosives, the following publications, which may be obtained free of cost on request to the Director of the Bureau of Mines, Washington, D. C., are of interest:

Technical Paper 18. Magazines and Thaw Houses for Explosives, by C. Hall and S. P. Howell.

Bulletin 80. A Primer on Explosives for Metal Miners and Quarrymen, by C. E. Munroe and C. Hall.

Miners' Circular 19. The Prevention of Accidents from Explosives in Metal Mining, by Edwin Higgins.

That a determined and intelligent effort on the part of foremen to prevent accidents will succeed, is evidenced by the continued decrease of injuries. This month we show a reduction over January, 1914, of 61.51 per cent. This continued good record is gratifying and prompts us to extend congratulations to you who have made it possible. Now let us all endeavor to cut out the unnecessary accidents, and we shall have a record that will entitle us to some degree of prominence in Safety First work.—*The Ingot,* February, 1915. Published monthly by the General Safety Committee of the Raritan Copper Works, Perth Amboy, N. J.

The Miners Safety Bear Club now has close to 4,000 members.

LIST OF SKETCHES OF SAFETY DEVICES

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California mine operators. In asking for any of the drawings, they may be referred to by number.

No.

1—Arm and Leg Splints.
2—Electric Pull Switch for Mine Bell Signal.
3—Safety Hook for Bucket.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
7—Details of Safety Clutch for Cage.
8—Detail Sketch of Safety Catch for Cage.
9—Safety Catch for Cage.
10—Miscellaneous Parts of Cage.
11—Shaft Cover for Sinking.
12—Safety Crosshead for Bucket.
13—Iron Drill Rack.
14—Lock Hook for Bucket.
15—Grid Iron for Protection at Collar of Ore Chute.
16—Iron Door.
17—Alarm Bell for Cage.
18—Standard Shaft Gate (Swing).
19—Safety Crosshead.
20—Removable Bonnet for Skip.
21—Cover for Skip.
22—Underground Dry Closet.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
26—Semiautomatic Gate for Mine Shafts.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
31—Gate for Shaft Collar.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
35—Cage Safety Catch Testing Device.
36—Safety Cage for Ladders.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
39—Cabinet and Rack for Mine Rescue Apparatus.
40—Change House.
41—Guard for Rip Saw.
42—Riley Two Deck Cage.

43—Automatic Side Dump Car.
- (a) Standard Incline Trip.
- (b) Draw Bar.
- (c) Lower Hinge of Dumping Mechanism.
- (d) Door Catch Angles.
- (e) Side View, Side Dump Car.
- (f) Details.
- (g) Details.
- (h) Details.
- (i) Details.
- (j) Details.

44—Underground Dry Closet.
45—Guard for Tram Car.
46—Underground Latrine.
47—Door for Cage.
48—Safety Crosshead.
49—Shaft Gate.
50—Trolley Support Methods.
51—Underground Toilet Car.
52—Sanitary Dry Closet.
53—Candle Holder for Miners.
54—Toboggan Stretcher for Underground Use.
55—Circular Removable Bonnet for Skips.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

Air Compressor Cooling with Water Barrels (Illus.).
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Drifting with a Stoper (Illus.).
Improved Safety Door for Dumps (Illus.).
Bucket-Dumping Device (Illus.).
Regarding Primers and Misfires.
Device to Aid in Fuse Spitting (Illus.).
Proper Way to Spit Fuses (Illus.).
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Burning Empty Dynamite Cases.
A Fire-Bucket Float (Illus.).
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
Automatic Landing Chairs (Illus.).
Spillage and Sinking Pocket (Illus.).
Crossheads for Bucket Hoisting (Illus.).
Runaway Tubs or Hutches (Illus.). A safety hook for shafts of slight inclination.
How to Splice Wire Rope (Illus.).
Miners' Dwellings (Illus.).
Concrete-block Mine Houses (Short).
A Simple Chain Ladder (Short).

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A Simple Chain Ladder (Short).

Wood versus Steel Mine Ladders (Illus.).
Capital Mine Steel Ladders (Illus.).
A Simple, Strong Chute (Illus.).
A Substantial Ore Chute (Illus.).
Types of Chutes and Chute Gates (Illus.).
Removable Chute Spray (Illus.).
Drinking Fountain for a Mine (Illus.).
Water Disinfecting Outfit for Field Use (Illus.).
Septic Tank for Underground Latrine (Illus.).
Four-deck Shaft-repair Cage (Illus.).
Cover for Shaft Ladderway (Illus.).
Simple Folding Shaft Gate (Illus.).
Hinge for Shaft Doors (Illus.).
Shaft Timbering and Headgear on the Mesabi Range (Illus.).
Light Shaft Timbering (Illus.).
Locked Signal System (Illus.).
Bell-wire Arrangement in Sinking (Illus.).
Gravity Release Electric Signal Box (Illus.)
Warning Bell for Topman (Illus.).
Raising a Gin Pole (Illus.).
Straightening a Tall Leaning Chimney (Illus.).
Safety Staging Hook (Illus.).
Methods of Stope Timbering (Illus.).
Emergency Pipe Wrench (Illus.).
Timbering for Air-check Doors in Motor-haulage Drift (Illus.).
Ventilating a Long Drift.
Water-tank Indicating Gauge (Illus.).

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BULLETIN No. 3

RELATING TO

Safety and Efficiency in Mines

OCTOBER, 1916

Issued by the
Industrial Accident Commission
of the
State of California

In Co-operation with
United States Bureau of Mines

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Chief Mine Inspector, Industrial Accident Commission, and
Mining Engineer, U. S. Bureau of Mines.

INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA

IN CO-OPERATION WITH UNITED STATES BUREAU OF MINES

BULLETIN NO. 3.

RELATING TO SAFETY AND EFFICIENCY IN MINES.

By EDWIN HIGGINS.

FOREWORD

It is proposed to send out from time to time, to the operators of mines in California, bulletins containing suggestions relating to safety and efficiency in mining. There will be included in each issue a list of drawings of various devices, copies of which may be obtained free of cost on request to the Chief Mine Inspector. Each bulletin will contain a discussion of the causes and prevention of accidents in connection with some particular phase of mining. The operators of mines are invited to take part in the discussion of any subject in which they are especially interested, to send in any information that they feel would be of interest to others, and to ask any questions concerning mine safety that they might wish to have answered. They may feel free to ask for copies of any of the drawings that are listed.

VENTILATION IN METAL MINES

Mine ventilation has an important bearing on the cost of producing a ton of ore. Impure air, together with excessive heat and high humidity, not only seriously affect the efficiency of the miner; they may impair also his health and safety. These facts are of sufficient importance to warrant the close attention of every metal mine operator who would reduce his costs to a minimum. In recent years this subject has been given much thought by operators of large metal mines in various parts of the United States. Many of these companies now employ men whose chief duty is to see to the proper ventilation of the mine. In many cases fans have been installed, at great expense, in order to secure better ventilation.

It is purposed herein to set forth certain facts regarding the effect of poor ventilation in metal mines, and to offer suggestions for overcoming some of the difficulties that are often encountered. Lack of space prohibits a complete discussion of this subject.

Results of Poor Ventilation

During the past four years, engineers of the United States Bureau of Mines have had occasion to study metal mine ventilation in various parts of the United States. Much data has been procured relating to the important bearing that ventilation has on the cost of mining. Many pages could be written, in which there could be cited instances where poor ventilation resulted in greatly impaired efficiency of the miner. Also, many cases could be mentioned where miners have lost their lives in poorly ventilated working places.

The following case will serve to illustrate how the cost of production may be increased through poor ventilation: A certain large mine produced approximately 1,000 tons of ore per day at a cost of $1,000. The labor cost was about $750. The working places from which 300 tons of this production came were poorly ventilated. On account of the poor air and the heat in this part of the mine (85 to 90 degrees, relative humidity 95 to 100 per cent), it was estimated that the miners put in only one-half of their time in

effective work. These miners would have produced 600, instead of 300, tons had conditions been normal, thus increasing the total production of the mine to 1,300 tons per day. This would have reduced the labor cost from 75 to 57.7 cents per ton. This illustration is conservative. In a great many deep mines an even greater saving could be effected through improved ventilation.

Many cases were noted where muckers were overcome, and sometimes killed, by powder gases liberated from the muck pile. This was especially true in dead end drifts or stopes. While it is very often difficult to better the ventilation in dead ends, in most cases a simple expedient will suffice. In several large mines it was noted that, in opening new levels, drifts were run as far as 1,000 feet before making connection with the level above. In some cases it was found that muckers and trammers received an advance of 75 cents per day while working on these new levels. In these cases, the connection of the poorly ventilated drifts with the levels above would have been good investments. Trammers would not have required a bonus and better ventilation would have enabled them to produce a greater tonnage.

Causes of Vitiation and Pollution of Mine Air

The quality of air supplied to mine workings may be effected in two ways, viz: (*a*) by the consumption of the contained oxygen, and (*b*) by the production of poisonous gases, chiefly through the use of explosives.

Consumption of oxygen.—The consumption of oxygen and the production of carbon dioxide are directly related and may be brought about by the following processes:

Breathing of men.
Burning of various types of miners lamps.
Oxidation or rotting of timbers.
Oxidation of carbonaceous rocks.
Blasting.

The breathing of men and the burning of candles or lamps are of first importance only in mines containing little or no timber. In heavily timbered mines the consumption of oxygen and the production of carbon dioxide, through the oxidation of the timber, becomes a matter of great importance. Tests in mines of this kind indicate that the oxidation

of timbers alone consumes from three to four times as much oxygen as all of the other agencies combined. This was determined by a careful measurement of the amount of air going into the mine, analysis of the air issuing from the mine, and a close approximation of the amount of oxygen required for the breathing of the men and the burning of the lights.

Tests were made in the Bureau of Mines laboratories at Pittsburgh, Pa., to bring out, if possible, something definite regarding the quantity of oxygen consumed by timbers. Sawdust and shavings of different kinds of wood were placed in large glass containers. At the end of 39 days there was practically no change in the content of the air in the containers. The shavings and sawdust were then moistened and, 16 days later, additional air samples were taken. A marked increase in carbon dioxide and decrease in oxygen was noted. At the end of five months, air samples taken from the containers holding the moist sawdust showed that all of the oxygen had been consumed and all but a small percentage of it converted into carbon dioxide. The containers in which shavings were used showed about 10 per cent carbon dioxide and 10 per cent oxygen. On the whole, these experiments demonstrated that damp timbers will readily consume oxygen and give off carbon dioxide. The experiments were not carried far enough to determine accurately the amount of oxygen that would be consumed by certain kinds of timber under given conditions.

Production of poisonous gases.—In metal mining the poisonous gases usually encountered are those produced by the use of explosives. Many tests have been made to determine the percentage of the various gases evolved by blasting. While results have varied somewhat, it may be said that the detonation of explosives most generally used in metal mines produces relatively large quantities of carbon dioxide, carbon monoxide and varying small quantities, or traces, of the oxides of nitrogen, hydrogen sulphide and sulphur dioxide, depending on conditions attending the use of the explosive. Tests made by the Bureau of Mines, in which straight nitroglycerine, low freezing ammonia, and gelatine dynamites were used, brought out the facts that the gelatine dynamites evolved the smallest quantities of noxious gases, and that this class of explosive produces a minimum proportion of harmful gases when it is properly and completely detonated. It

was also brought out that when explosives have aged to such an extent as to materially decrease their sensitiveness, when weak detonators are used, or when the explosive is used in a frozen or nearly frozen condition, a greater quantity of poisonous gases is evolved. Several samples of 40 per cent gelatine dynamite were procured from different manufacturers and all of them produced poisonous gases on detonation. The percentage of carbon monoxide varied from 3 to 5.7 per cent, and of hydrogen sulphide from 0.7 to 4.1 per cent. As a final result of these investigations a 40 per cent strength gelatine dynamite was prepared according to the following formula: Nitroglycerine, 33 per cent; nitrocellulose, 1; sodium nitrate, 54; combustible material (flour), 11; calcium carbonate, 1; total, 100 per cent. The products of combustion from this explosive were collected in a Bichel gauge (described in Bureau of Mines Bulletin 15, page 103) and analyzed by A. L. Hyde, with the following result: Carbon dioxide, 51 per cent; oxygen, 0.9; methane, 0.7; nitrogen, 47.4; total, 100 per cent.

Effect of Impure Air on Men

Presence of carbon dioxide.—Under ordinary conditions in metal mines the presence of carbon dioxide indicates a corresponding lowering of the oxygen content of the air. It may be well to state here that pure, free air, analyzed by volume, contains 20.93 per cent oxygen, 0.03 per cent carbon dioxide, and 79.04 per cent nitrogen.

A man may breathe an atmosphere containing a large percentage of carbon dioxide with less injurious effect where the content of oxygen is not low. The symptoms in man, when breathing an atmosphere very low in oxygen, or high in carbon dioxide, are somewhat similar. In both cases breathing will become deep and rapid. Deep breathing caused by excess of carbon dioxide does not necessarily mean immediate danger, while the same condition brought about by low oxygen places a man in imminent danger.

To discuss adequately the effect produced on man by breathing atmospheres containing various percentages of oxygen and carbon dioxide would require many pages. Inasmuch as, under ordinary conditions, carbon dioxide is usually found in metal mines in amounts slightly less or equal to the

molecular equivalent of the oxygen consumed, it will serve all practical purposes to discuss the effect of low oxygen and excess carbon dioxide combined. The first effect of breathing air containing from 2 to 3 per cent carbon dioxide (18 to 19 per cent oxygen) is headache and dizziness. Larger percentages of carbon dioxide cause extreme panting. As much as 10 per cent carbon dioxide, with a corresponding low oxygen content of the air, is dangerous to the life of the ordinary man.

Ordinarily a candle will go out in air containing about 17 per cent of oxygen; carbide lamps will be extinguished in an atmosphere containing 12 to 13 per cent of oxygen. For this reason it is dangerous to depend upon the carbide lamp to give an indication of a dangerous atmosphere. When a candle will not burn in a working place it is time for the miner to retreat. His efficiency will be impaired even before the candle goes out, or when the oxygen content of the air has dropped below 19 per cent.

Carbon monoxide and other poisonous gases.—Carbon monoxide is present in large quanties in the exhaust of gasoline motors. During a mine fire, especially if the timber is damp, much carbon monoxide is produced. This gas is a product of incomplete combustion. Under ordinary conditions in a mine it is chiefly the product of blasting; imperfect detonation, or the burning of powder, produces larger quantities.

As little as 0.2 per cent carbon monoxide is dangerous to life if breathed for approximately one-half hour. Larger amounts may be fatal in correspondingly shorter intervals of time. No more than 0.05 per cent carbon monoxide should be allowed in any mine working at any time.

While less is known of the effect of the nitrous oxides, the best authorities state that a trace of these gases in mine air is dangerous.

Heat and Humidity

It may be said that heat is developed in underground mines through the following agencies: Rock temperatures, crushing and working of rock and timber, oxidation of timber, presence of men and lights, operation of machinery and presence of steam lines connected thereto, and blasting. The

most potent of these agencies for producing excessive heat are rock temperature and the oxidation of timber.

Measurement of temperature alone in a working place will not determine whether or not conditions in this place are conducive to efficient work and the safety of the men. An all important feature is the relative humidity of the air; this, considered in connection with the temperature, will give a satisfactory basis on which to work.

Haldane* states. "The normal body temperature of a man is from 98° to 101° F., and in order to obtain efficiency in work, his temperature should not exceed this upper limit. The body may be cooled by radiation, conduction and evaporation (sweating). Cooling by evaporation is the most important in deep mine ventilation. Evaporation from the body can only occur when the dew point of the surrounding air is below body temperature, 98° F. * * * In order to maintain the body temperature in hot mines, where one is working, it is necessary to keep the skin at a lower temperature than the interior of the body. The body temperature may be maintained when 78° F. (wet bulb) in still air, and 88° F. (wet bulb) in good moving air, is shown. * * *"

The degree of saturation, or relative humidity, of the air means the percentage of water vapor present with reference to complete saturation as 100 per cent.

The instrument most commonly used in determining the relative humidity of mine air is what is known as a sling psychrometer. This consists of two thermometers so mounted that they may be whirled about a handle. One of these thermometers has a small piece of muslin wrapped around its bulb; this is called the wet bulb. The muslin is dipped into water and the psychrometer is whirled for a short period of time. Unless there is complete saturation, the wet bulb theremometer will register a lower temperature than will the dry bulb theremometer.

Relatively dry air, of course, will absorb greater amounts of moisture from the wet bulb and hence will reduce the temperature of the wet bulb thermometer, by evaporation, to a greater extent. Air containing relatively large amounts of water vapor will reduce the temperature of the wet bulb thermometer less noticeably. The readings of the two

*J. S. Haldane, Jour. Chem. Met. & Min. Soc., South Africa, Vol. 11, 1910, page 227.

thermometers are definite functions of the relative humidity and temperature. The human body may be compared to the wet bulb thermometer. If the relative humidity of the air is high, evaporation from the body, and consequent cooling of the body, will be slow. Therefore, it follows that the lower the humidity can be kept, the greater will be the cooling effect on man.

Frequently the air entering a mine contains relatively small amounts of water-vapor; in other words, its relative humidity is low. As this air courses through damp mine workings its relative humidity rises. The air issuing from most metal mines has a relative humidity of more than 90 per cent. In a great many cases from 95 to 100 per cent is registered. This means that the air passing out of the mine carries practically all of the moisture possible at the existing temperature. Such air has little or no effect in cooling the human body by evaporation. Sufficient air should be supplied to the mine so that, by the time it reaches the farthermost workings, it will not be so laden with moisture that it will have lost its capacity for cooling through evaporation. It is my belief that miners who work in temperatures about 80 degrees wet bulb (relative humidity 95 to 100 per cent) show a falling off in energy.

Natural and Mechanical Ventilation

In order to force air through a mine it is necessary that there be some motive power. In natural ventilation, the excess weight of the down-cast air, over the weight of an equal volume of heated up-cast air, constitutes what is referred to as the ventilating motive force. The greater temperature of the up-cast air may be due to the greater depth of the up-cast shaft, the presence of much decaying timber, steam lines, men and lights, etc. Another factor which has some effect is the difference in temperature between the intake and return air openings.

When the ventilating motive force obtained by natural means is not sufficient, it becomes necessary to resort to mechanical means to increase it. Modern practice is to use various types of fans in cases where natural ventilation is insufficient.

Studying Conditions in the Mine

It is a simple matter to determine whether sufficient air is being carried to various parts of the mine. The apparatus necessary are a Haldane black damp tester, for the determination of the percentage of oxygen in the air, and a sling psychrometer, for the determination of temperature and humidity. A table of humidity readings is necessary in connection with the use of the psychrometer. An anemometer is also useful in determining the amount of air passing at different points in the mine. A half day will suffice to make the necessary preliminary tests, in even a large mine. Should it be found that the oxygen content of the air in working places is as low as 18½ per cent, or the wet bulb temperature higher than 75 degrees (relative humidity 95 to 100 per cent), steps should be taken to increase the amount of air going to these working places.

The trouble may be that an insufficient quantity of air is entering the mine; or it may be that the ventilating current is being short-circuited and is not reaching certain parts of the mine.

It may be well to consider first the proper distribution of such air as is available by natural means. It is considered best to carry the ventilating current first directly to the lowest portions of the mine and distribute it thence to the various working places and finally to the up-cast shaft. The placing of doors, for preventing short circuits of air and for deflecting the ventilating current in certain directions, is a most important factor. If sufficient air can not be provided by regulating the course of the air current, then it will be necessary to turn to some type of mechanical appliance for increasing the supply of air. Lack of space prevents a discussion of the use of mine fans.

Ventilation of Dead Ends

In most metal mines the main openings are usually fairly well ventilated. The greatest trouble is experienced in remote stopes or in dead ends. There are several means of removing foul air from, and carrying fresh air to, places remote from the main air current of the mine.

In cases where the dead end is directly connected with the surface, many ingenious schemes for ventilation have been

put in use. Among these may be mentioned the use of sails, so rigged as to divert a current of air into a pipe leading to the face. The use of ordinary stovepipe, or galvanized iron pipe, leading from the face of a tunnel to the portal and there connected by an elbow to an upright pipe, will cause a slight circulation of air. This circulation may be increased if a stove be added to the outside equipment. The point at which the pipe enters the stove (or hearth) should be of greater elevation than the intake end of the pipe at the face. A very long tunnel in a Mexican mine was successfully ventilated by means of a drain tunnel in the floor, made air-tight by means of slabs and cement. Considerable water flowed out through the drain pipe and this served to set up a circulation of air.

In the sinking of prospect shafts, the use of a stove or charcoal pot, placed on one side of the shaft, or better still, beneath a stack or pipe leading down the shaft, has proved efficient. If the shaft be of two compartments, with a partition dividing them, the use of a stove in one compartment causes an air circulation.

In ventilating dead ends not directly connected with the surface, a different problem is presented. In general, it is most efficient to draw the foul air from the face through a pipe placed near the back or roof of the drift or crosscut. Forcing air to the face through a pipe tends to cause eddies and works directly against the natural tendency of heated air to rise. For carrying the air, there is probably nothing better than ordinary galvanized iron pipe; its size will depend on the quantity of air it must carry.

In general, it may be said that there are three methods usually available for forcing the air through, or drawing it out of, the pipe, viz: the use of electrically driven centrifugal fans, the use of fans driven by water power, and the employment of the compressed air jet. Where electrical power is available, it is probable that the use of the electrically operated fan is cheapest and most efficient.

In the absence of other power, the compressed air jet may be employed to great advantage. This system may be used with pipes as small as 2 or 3 inches in diameter; it also works well with galvanized pipe of larger diameters. The important feature in the use of the compressed air jet is to

so place the nozzle that the compressed air issuing from it will spread out and fill the pipe before leaving it. In small pipes this condition will be fulfilled if a jet is placed from 12 to 18 inches from the outlet end. The best results are obtained by turning on the full pressure of compressed air and regulating the amount delivered by the size of the aperture of the jet. For the smaller sizes of pipes, a $\frac{3}{8}$ to $\frac{1}{2}$ inch air pipe with a nozzle $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter will serve the purpose.

LIST OF SKETCHES OF SAFETY DEVICES

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California mine operators. In asking for any of the drawings, they may be referred to by number.

No.
1—Arm and Leg Splints.
2—Electric Pull Switch for Mine Bell Signal.
3—Safety Hook for Bucket.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
7—Details of Safety Clutch for Cage.
8—Detail Sketch of Safety Catch for Cage.
9—Safety Catch for Cage.
10—Miscellaneous Parts of Cage.
11—Shaft Cover for Sinking.
12—Safety Crosshead for Bucket.
13—Iron Drill Rack.
14—Lock Hook for Bucket.
15—Grid Iron for Protection at Collar of Ore Chute.
16—Iron Door.
17—Alarm Bell for Cage.
18—Standard Shaft Gate (Swing).
19—Safety Crosshead.
20—Removable Bonnet for Skip.
21—Cover for Skip.
22—Underground Dry Closet.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
26—Semiautomatic Gate for Mine Shafts.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
31—Gate for Shaft Collar.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.

35—Cage Safety Catch Testing Device.
36—Safety Cage for Ladders.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
39—Cabinet and Rack for Mine Rescue Apparatus.
40—Change House.
41—Guard for Rip Saw.
42—Riley Two Deck Cage.
43—Automatic Side Dump Car.
(a) Standard Incline Trip.
(b) Draw Bar.
(c) Lower Hinge of Dumping Mechanism.
(d) Door Catch Angles.
(e) Side View, Side Dump Car.
(f) Details.
(g) Details.
(h) Details.
(i) Details.
(j) Details.
44—Underground Dry Closet.
45—Guard for Tram Car.
46—Underground Latrine.
47—Door for Cage.
48—Safety Crosshead.
49—Shaft Gate.
50—Trolley Support Methods.
51—Underground Toilet Car.
52—Sanitary Dry Closet.
53—Candle Holder for Miners.
54—Toboggan Stretcher for Underground Use.
55—Circular Removable Bonnet for Skips.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

Air Compressor Cooling with Water Barrels (Illus.).
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Drifting with a Stoper (Illus.).
Improved Safety Door for Dumps (Illus.).
Bucket-Dumping Device (Illus.).
Regarding Primers and Misfires.
Device to Aid in Fuse Spitting (Illus.).
Proper Way to Spit Fuses (Illus.).
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Burning Empty Dynamite Cases.
A Fire-Bucket Float (Illus.).
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
Automatic Landing Chairs (Illus.).

Spillage and Sinking Pocket (Illus.).
Crossheads for Bucket Hoisting (Illus.).
Runaway Tubs or Hutches (Illus.). A safety hook for shafts of slight inclination.
How to Splice Wire Rope (Illus.).
Miners' Dwellings (Illus.).
Concrete-block Mine Houses (Short).
A Simple Chain Ladder (Short).
Wood versus Steel Mine Ladders (Illus.).
Capital Mine Steel Ladders (Illus.).
A Simple, Strong Chute (Illus.).
A Substantial Ore Chute (Illus.).
Types of Chutes and Chute Gates (Illus.).
Removable Chute Spray (Illus.).
Drinking Fountain for a Mine (Illus.).
Water Disinfecting Outfit for Field Use (Illus.).
Septic Tank for Underground Latrine (Illus.).
Four-deck Shaft-repair Cage (Illus.).
Cover for Shaft Ladderway (Illus.).
Simple Folding Shaft Gate (Illus.).
Hinge for Shaft Doors (Illus.).
Shaft Timbering and Headgear on the Mesabi Range (Illus.).
Light Shaft Timbering (Illus.).
Locked Signal System (Illus.).
Bell-wire Arrangement in Sinking (Illus.).
Gravity Release Electric Signal Box (Illus.)
Warning Bell for Topman (Illus.).
Raising a Gin Pole (Illus.).
Straightening a Tall Leaning Chimney (Illus.).
Safety Staging Hook (Illus.).
Methods of Stope Timbering (Illus.).
Emergency Pipe Wrench (Illus.).
Timbering for Air-check Doors in Motor-haulage Drift (Illus.).
Ventilating a Long Drift.
Water-tank Indicating Gauge (Illus.).

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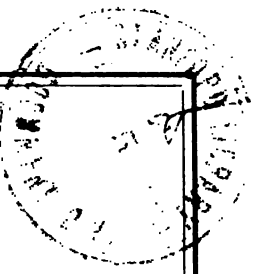

BULLETIN No. 4

RELATING TO

Safety and Efficiency in Mines

FEBRUARY, 1917

Issued by the

Industrial Accident Commission

of the

State of California

In Co-operation with

United States Bureau of Mines

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA

IN COOPERATION WITH UNITED STATES BUREAU OF MINES

BULLETIN No. 4.

RELATING TO SAFETY AND EFFICIENCY IN MINES

By H. M. WOLFLIN.

FOREWORD

It is proposed to send out from time to time, to the operators of mines in California, bulletins containing suggestions relating to safety and efficiency in mining. There will be included in each issue a list of drawings of various devices, copies of which may be obtained free of cost on request to the Chief Mine Inspector. Each bulletin will contain a discussion of the causes and prevention of accidents in connection with some particular phase of mining. The operators of mines are invited to take part in the discussion of any subject in which they are especially interested, to send in any information that they feel would be of interest to others, and to ask any questions concerning mine safety that they might wish to have answered. They may feel free to ask for copies of any of the drawings that are listed.

MINE SAFETY WORK AND THE MERIT RATING SYSTEM.

A reduction in the number of accidents in California mines eventually must be followed by a reduction in the rate of compensation insurance. At the present time a merit rating scheme of insurance for California mines is being prepared, and it is probable that the system will be put into effect in the near future. Although considerable work has already been done on the merit rating schedule, and it will be completed in a short time, it must then be approved by the State Insurance Commissioner before it can be made effective. All the present indications point to such an approval being secured without delay.

On which side of the average will your mine fall when the merit rating system is applied? Will you be penalized for the many dangerous conditions which exist, and consequently have to pay a high rate for your insurance, or will your premium be reduced by the safety equipment which you have installed and the safety organization which you have perfected? The answer will depend on your efforts for safety.

These pages are published to notify you of the situation which is developing and to give you a chance to get your mine on the "credit" side of the safety ledger. If your safety work is "in the red" now, do not let it stay there. You can accomplish much toward pulling it out if you will follow the suggestions made in Bulletins 1, 2 and 3, relating to safety and efficiency in mines, issued by the Industrial Accident Commission. In Bulletin No. 2, outlines are given for the organization of safety work. These show the approximate cost of safety work at certain mines and explain how excellent results have been obtained where the methods have been used.

If the merit rating system is put into effect, it will place safety work on a dollars and cents basis and will reward the careful operator and penalize the careless one. There has never been a time in the history of mining in California when such quick returns could be obtained from safety work, as will be possible during the next few months. It will be of advantage to every operator carrying insurance immediately

to improve safety conditions so that the mines will be in shape for the inspectors who will rate them. Because of the volume of business to be handled, it is probable that a second inspection cannot be made within a short time after a rating is given, therefore the better your rating in the first place the more money you will save on insurance premiums. In the merit rating schedule which is proposed, safety organization and all safety work count heavily in favor of the mine where such efforts are being made. *Now* is the time to act. After the merit rating schedule is put into effect there will not be sufficient time to organize your safety work before the inspections and ratings are started. Remember that considerable time will be required for you to obtain a rerating and receive credit for safety work done after your mine has once been rated. So, in anticipation of the coming of the merit rating system, get your mine in shape, organize your safety work and reduce your insurance rates by reducing your accident hazards.

Even if some unforeseen difficulty should indefinitely delay the merit rating plans (and this seems very improbable at the present time), the safety work which we urge must result in direct financial returns. The only consistent way to work for a reduction in insurance premiums in this state is to reduce the number of accidents. When a material reduction is made the rates *must* come down. So the California operator can not possibly lose anything by at once spending some time and money on safety work. It is cheaper to pay for the prevention of accidents than to pay for the damage the accidents do, and it does not matter whether you choose to pay for such damage directly, or through the medium of high insurance rates. These statements may look too good to be true, but you may be assured that if there is any way you can lose by doing safety work, we have failed to discover that way. From any angle that you look, it is simply a case of reducing your insurance rates by reducing your accidents.

It is frankly admitted that results of safety work are frequently discouraging at the start. For instance, at a large mine outside of the state there were more fatal accidents the first year that safety work was seriously undertaken than there had been the previous year, but a careful study of all accidents, fatal and nonfatal, showed that the total number of accidents had materially decreased and the following

year there was a considerable reduction in the fatal, as well as the nonfatal, accidents. The officials at this mine had confidence in the work they were doing and were not discouraged when the first year's work failed to give the full return which they had expected; they kept everlastingly at it and got excellent results in the end.

When you start to drive a drift or crosscut or to sink a shaft to a body of ore you do not expect to have the job completed in a day, or, many times, even in a month. In some cases it takes a year or two to finish. No more can you expect to immediately reduce the number of your accidents by safety work. Perseverance, time and patience are required to reduce accidents, as well as to reach the ore for which you are driving, but in every instance where these qualities have been consistently applied to safety work the most encouraging results have been obtained in the reduction of accidents. When drifting for ore you may not be sure that the ore is there, but when doing safety work you know there are accidents to be prevented. You are working in the daylight instead of in the dark—working on a certainty instead of a supposition, and while the ore must be there to make the mine pay, very few accidents are necessary and chargeable to the basic hazards of the industry.

No amount of inspection or safety work that can be carried on by state or federal officials can possibly accomplish as great a reduction in accidents as can be accomplished by consistent safety work by mine operators and officials, especially if an earnest and sustained effort is made to enlist the cooperation of the miners.

Help all men in authority in and about your mine to realize the importance of being careful, so that they will develop careful instincts in the miners. "Personal caution is the greatest safeguard." "It is everybody's business to be careful; yet it must be made some-particular-body's business to see that everybody is careful."* The largest and by far the most telling safety work that can be done must go to the very root of carelessness, namely, the indifference and ignorance which are responsible for so many accidents. The miner's safety is clearly a part of the foreman's responsibility. Help your foreman to realize this responsibility.

*These quotations and some of the thoughts which follow are taken from the May issue of "The Spirit of Caution."

While the industry and the state and the nation at large are benefited by a reduction in mine accidents, and the consequent increase in economic efficiency, these gains are as nothing compared to the financial gain and the satisfaction to be derived by the mine operator.

So: Reduce your insurance rates by reducing your accidents.

MINE FIRES AND RESCUE APPARATUS.

Need of preparation.

Unfortunately, there seems to be a feeling among some of the mine operators of California that there is no danger from fire in the mines in this state. This feeling is not justified either by past experience or by observation of actual conditions which exist. Several men lost their lives at small mine fires in this state during 1915 and others have been killed by mine fires in the past. The fire hazard in many of the California mines is fully as great as in mines in other states where disastrous fires have occurred, so there is absolutely no reason to believe that California can be as fortunate in the future as it has been in the past. Therefore, it is well for the thoughtful operator to give some consideration to the methods of preventing and fighting mine fires. In this connection the following extract from a recent publication of the Bureau of Mines may be of interest:

> "In many metal mining centers there seems to be a common opinion that the danger from underground fires is slight, and that the principal hazard from underground magazine explosions is from violence rather than from the gases liberated. Experience has shown that in metal mines in different parts of the country numerous fires have taken a heavy toll of human life and have destroyed much property. As examples may be cited the disastrous fires in some of the Michigan, Montana, Nevada, and Arizona mines, which have required the expenditure of millions of dollars and the performance of years of difficult and dangerous work before they were under control. It has also been shown by actual experience that the most disastrous effects of underground magazine explosions have often been caused by the carbon monoxide and nitrous oxide gases liberated, which asphyxiated men who were working in remote parts of the mine. These gases are very deadly and have been

known to travel considerable distances from the seat of the explosion without becoming sufficiently diluted by the mine air to be rendered harmless.

"Although it is not easy to set fire to wet timber underground, such timber is ignited much more frequently than is believed by those inexperienced with mine fires. It also should be borne in mind that timber that appears to be wet may have dry spots and these are the spots that careless miners are likely to expose to the flame of a carbide lamp or to a candle 'snuff', with the result that a fire will be started.

"A gas producer, whether it burns wood or coal, generates large quantities of carbon monoxide. An underground fire burning wet timber acts something like a wood burning gas producer. It emits large volumes of smoke and generates carbon monoxide in deadly proportions. At the Cherry mine the burning of coal was not an important factor, but the destruction of life was due to smoke and gases generated by the burning of timber stations and shaft lining. Many metal mines contain large quantities of timber and the fire hazard is even greater than in some coal mines. Even where small amounts of timber are used there is considerably more danger than would at first appear. The Tonopah Belmont fire burned out quickly because there was not much timber for it to feed upon, but many men were killed by the smoke and gases from it. There are other cases on record where the burning of a single stull or stick of timber has seriously threatened the lives of men. Because of relatively poor ventilation in metal mines a small fire may have serious effects. For example, in mine rescue training work, 'dead-end' drifts have frequently been bulkheaded off and used as 'smoke rooms'. To burn merely half a dozen powder boxes and a little refuse in such a place will make an atmosphere that will extinguish carbide lights and may contain enough carbon monoxide to quickly overcome a man. In one instance a drift 5 by 7 by 400 feet was used. The burning of powder boxes and refuse produced an atmosphere in the vicinity of the fire that contained 2.4 per cent of carbon monoxide.

"As less ventilating apparatus and watering arrangements other than for fire fighting are required in metal mines than in coal mines, there is perhaps more urgent need for mine rescue and recovery training in metal mines than in coal mines. This need is most evident to one who arrives at the scene of a fire or explosion disaster in a metal mine and finds the man in charge unable to cope with the situation because of a total lack of equipment and prearranged plans."

Mine rescue apparatus.

Mine rescue apparatus is indispensable at certain rare intervals in the course of mining operations, but it should be trusted only to men who have had thorough training and experience in its use. It may be compared to a revolver kept to protect valuable property. No one would think of giving a revolver to a man who knows nothing of its mechanism or its use, and expecting him to protect property with it. Similarly, it is worse than foolish—it is extremely dangerous—to place mine rescue apparatus in the hands of inexperienced men. A man who knows nothing of firearms is more likely to harm himself or his companions by attempting to use them than he is to protect himself or the property in his charge. So, mine rescue apparatus in the hands of inexperienced men is a very serious menace. If the apparatus is used, trained men must be available. Furthermore, no one would think of depending for protection on a revolver that he did not know was in good working condition, and, similarily, mine rescue apparatus must be in perfect condition to be of value; if in bad condition, it is worse than useless, it is a menace. Only by making tests on the apparatus is it possible to know whether or not it is in proper working order. It may have been charged and tested and found to be in excellent condition, and after remaining idle for a month may get out of adjustment and be in such condition that if a man should wear it in poisonous gas his life would be sacrificed.

The reports which the Industrial Accident Commission requires on mine rescue apparatus call for the minimum number of tests which it is possible to make and obtain reliable indications of the condition of the apparatus. Therefore, care should be taken to see that these tests are made regularly and carefully, as required by the Mine Safety Rules.

Unless men take training regularly in the use of the apparatus, it is dangerous for them to attempt to use it in an emergency, and no good can be accomplished by their attempts to employ it. Experience of the Bureau of Mines has shown that men who have been well trained in the use of the apparatus and have not practiced with it for several months are not in good condition for actual rescue, exploratory, or fire fighting work. Therefore, neglect to test or train with

the apparatus renders it worse than useless. The superintendent whose mine is served by a cooperative mine rescue station, or by apparatus kept at the mine, would do well to think seriously of these things and to see that they receive attention.

Under the best of conditions mine rescue work is dangerous. During the past six years the United States Bureau of Mines has lost four men who were wearing rescue apparatus in a poisonous atmosphere underground. Under date of November 10, 1916, the director of the United States Bureau of Mines wrote as follows:

> "A man wearing the present makes of oxygen rescue apparatus in a noxious atmosphere can not safely exert himself as much as when in the open air unencumbered. Unsuspected physical defects, such as fatty degeneration of the heart, kidney affections, lung trouble, may result disastrously to a person wearing mine rescue apparatus. A man encumbered with 38 or 40 pounds of mine rescue apparatus needs to be in the best possible physical condition and should be sure that he is not in an unfit condition for hazardous work."

It is the duty of every mine superintendent where mine rescue apparatus is available to see that every rescue man, when he has to use the apparatus, is free from physical disorders that might endanger his life or safety. At regular intervals men who take mine rescue training should be given thorough physical examinations, including blood tests, in order to be sure that they are fit for rescue work.

The following circulars recently issued by the Bureau of Mines may be of interest to users of apparatus:

> "A most thorough examination should be made of all rescue apparatus prior to wearing it in a noxious atmosphere, and no apparatus should be worn under these circumstances which is not in a safe working condition.
>
> "Special attention should be given to determine whether leakage occurs in the circulating system when the breathing bag is inflated. To determine this leakage, apply soap suds by means of a brush to the part to be tested, paying special attention to rubber tubing and all connections.
>
> "If a joint is to be tested and it is difficult or impossible to apply soap suds, light a strand of lamp wicking and hold the glowing end near the joint. The glowing end

will brighten or burst into flame if leakage is present at this point.

"Rubber mouthpieces should be carefully examined to determine whether they have become defective due to wear or deterioration of the rubber. Often by bending or twisting the mouthpiece defects may be detected or developed which otherwise would not be discovered by a superficial examination.

"In making explorations with apparatus the advance party should never, under any circumstances, proceed more than 1,500 feet beyond the fresh air base. Where conditions are such as to make traveling difficult as, for instance, the presence of bad falls or wreckage on the roadways, then the advance crew should not proceed more than 1,000 feet ahead of the fresh air base. The life line should be used freely, particularly in the latter case."

"All Fleuss apparatus should be equipped with chains and spring hooks for the purpose of locking the main supply valve in an open position.

"The ring is placed over the outlet nipple of the oxygen bottle and the hook is snapped on the wheel of the main supply valve after the valve has been opened about one and one-half turns. It is then impossible for the valve to be inadvertently or accidentally closed or the stem entirely screwed out unless the wearer disengages the hook from the wheel. This should never be done unless it is absolutely necessary to shut off the oxygen.

"The foreman should see that these hooks are used and properly applied in all training work in order to emphasize the importance of this feature. He should also strongly insist that under no circumstances should the oxygen supply be turned off simply for the purpose of conserving the oxygen, as this is a dangerous and unnecessary practice.

"It is desirable to keep the valve controlling the oxygen supply to the finimeter tube open at all times. It should only be closed in case of an accident to the tube or gauge.

"Furthermore, if the gauge valve is closed it may be misleading to the wearer or crew captain since he might read the gauge without opening the valve and thus get the pressure of the oxygen entrapped within the tube, rather than that in the bottles.

"In the use of the apparatus it is desirable as far as possible to set all valves properly in the beginning and not open or close them unless it is absolutely necessary during the work. If this course is followed, the chances of inadvertently or accidentally turning the wrong valve will be greatly reduced."

During the past six years a number of men have been rescued by wearers of mine rescue apparatus and many men have had their lives saved because such apparatus was available for use in fire fighting and exploratory work. The apparatus is almost indispensable at a mine fire or after a serious underground powder explosion, but it is imperative that attention be paid to the precautions mentioned before.

ACETYLENE LAMPS vs. CANDLES.

In Bulletin No. 1, relating to safety and efficiency in mines, attention was directed to the fact that the use of candles underground has been a prolific source of mine fires. In this connection it is encouraging to note that many of the California mines are abolishing the use of candles and adopting acetylene mine lamps. In addition to reducing the fire hazard, the substitution of carbide lamps for candles has generally resulted in cutting the cost of illumination just about one-half, where the men are left to care for their own lamps. Where lamp rooms are installed and the men are required to turn in their lamps on coming off shift so that the lamp man can clean, repair, and fill them before the next shift a further reduction in cost has been secured. The latter plan also insures each miner having a lamp in good order when he starts to work, and thus gives him better light and results in even greater efficiency and saving to the company by reducing the time that the miner must spend adjusting his lamp. Experience has shown that when each miner is left to take care of his own lamp he frequently neglects to properly look after adjustments and renewals of felts, washers, burners, etc., with the result that he has trouble with his lamp during the shift, and his efficiency is considerably reduced. Acetylene lamps must have a little attention in order to give good service.

LIST OF SKETCHES OF SAFETY DEVICES.

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California mine operators. In asking for any of the drawings, they may be referred to by number.

No.

1—Arm and Leg Splints.
2—Electric Pull Switch for Mine Bell Signal.
3—Safety Hook for Bucket.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
7—Details of Safety Clutch for Cage.
8—Detail Sketch of Safety Catch for Cage.
9—Safety Catch for Cage.
10—Miscellaneous Parts of Cage.
11—Shaft Cover for Sinking.
12—Safety Crosshead for Bucket.
13—Iron Drill Rack.
14—Lock Hook for Bucket.
15—Grid Iron for Protection at Collar of Ore Chute.
16—Iron Door.
17—Alarm Bell for Cage.
18—Standard Shaft Gate (Swing).
19—Safety Crosshead.
20—Removable Bonnet for Skip.
21—Cover for Skip.
22—Underground Dry Closet.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
26—Semiautomatic Gate for Mine Shafts.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
31—Gate for Shaft Collar.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
35—Cage Safety Catch Testing Device.
36—Safety Cage for Ladders.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
39—Cabinet and Rack for Mine Rescue Apparatus.
40—Change House.
41—Guard for Rip Saw.
42—Riley Two Deck Cage.

No.
43—Automatic Side Dump Car.
(a) Standard Incline Trip.
(b) Draw Bar.
(c) Lower Hinge of Dumping Mechanism.
(d) Door Catch Angles.
(e) Side View, Side Dump Car.
(f) Details.
(g) Details.
(h) Details.
(i) Details.
(j). Details.
44—Underground Dry Closet.
45—Guard for Tram Car.
46—Underground Latrine.
47—Door for Cage.
48—Safety Crosshead.
49—Shaft Gate.
50—Trolley Support Methods.
51—Underground Toilet Car.
52—Sanitary Dry Closet.
53—Candle Holder for Miners.
54—Toboggan Stretcher for Underground Use.
55—Circular Removable Bonnet for Skips.
56—Toilet Can for Use in Mines.
57—Drinking Water Keg for Use in Mines.
58—Sanitary Mouthpiece for Drinking Water Kegs.
59—Sanitary Toilet for Use in Mines.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

Air Compressor Cooling with Water Barrels (Illus.).
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Drifting with a Stoper (Illus.).
Improved Safety Door for Dumps (Illus.).
Bucket-Dumping Device (Illus.).
Regarding Primers and Misfires.
Device to Aid in Fuse Spitting (Illus.).
Proper Way to Spit Fuses (Illus.).
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Burning Empty Dynamite Cases.
A Fire-Bucket Float (Illus.).
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
Automatic Landing Chairs (Illus.).
Spillage and Sinking Pocket (Illus.).
Crossheads for Bucket Hoisting (Illus.).

Runaway Tubs or Hutches (Illus.). A safety hook for shafts of slight inclination.
How to Splice Wire Rope (Illus.).
Miners' Dwellings (Illus.).
Concrete-block Mine Houses (Short).
A Simple Chain Ladder (Short).
Wood versus Steel Mine Ladders (Illus.).
Capital Mine Steel Ladders (Illus.).
A Simple, Strong Chute (Illus.).
A Substantial Ore Chute (Illus.).
Types of Chutes and Chute Gates (Illus.).
Removable Chute Spray (Illus.).
Drinking Fountain for a Mine (Illus.).
Water Disinfecting Outfit for Field Use (Illus.).
Septic Tank for Underground Latrine (Illus.).
Underground Latrines for Mines (Illus. Description).
Four-deck Shaft-repair Cage (Illus.).
Cover for Shaft Ladderway (Illus.).
Simple Folding Shaft Gate (Illus.).
Hinge for Shaft Doors (Illus.).
Shaft Timbering and Headgear on the Mesabi Range (Illus.).
Light Shaft Timbering (Illus.).
Locked Signal System (Illus.).
An Effective Mine Signal System.
Bell-wire Arrangement in Sinking (Illus.).
Gravity Release Electric Signal Box (Illus.).
Automatic Locomotive Gong.
Warning Bell for Topman (Illus.).
Raising a Gin Pole (Illus.).
Straightening a Tall Leaning Chimney (Illus.).
Safety Staging Hook (Illus.).
Methods of Stope Timbering (Illus.).
Emergency Pipe Wrench (Illus.).
Timbering for Air-check Doors in Motor-haulage Drift (Illus.).
Ventilating a Long Drift.
Water-tank Indicating Gauge (Illus.).

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BULLETIN No. 5

RELATING TO

Safeguarding of a Gold Dredge

JUNE, 1917

Issued by the
Industrial Accident Commission
of the
State of California

In Co-operation with
United States Bureau of Mines

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA

IN COOPERATION WITH UNITED STATES BUREAU OF MINES

BULLETIN No. 5.

FOREWORD.

Pursuing our custom of issuing bulletins from time to time dealing with subjects pertaining to the mining industry of California and methods of safeguarding life in its different branches, we are issuing a bulletin on the Safeguarding of Gold Dredges which we trust will be of assistance to operators. The operators and employees are invited to make suggestions on safety work on gold dredges and we are ready at all times to answer any inquiries that may be addressed to us dealing with this subject.

RELATING TO SAFEGUARDING OF A GOLD DREDGE

By F. L. LOWELL, Deputy Mine Inspector.

The reduction in fatal accidents and permanent injuries on gold dredges was very marked during the year 1916 as compared to 1915. During 1915 there were six fatal accidents and seven permanent injuries, while during 1916 there was only one fatality and six permanent injuries. The difference between the number of dredges and men working in 1915 and in 1916 would not alter the percentage greatly.

We may say that this reduction in fatalities and injuries is due in great part to the safety work now being pursued throughout the state. Some of the dredging companies have carried on a more thorough safety campaign than others, and the results have proved the value of the experiment. In the case of the Natomas Company of California, the increase in efficiency of the employees, taken together with the approximate reduction of 30 per cent of a possible maximum 40 per cent, in their premiums, due to the merit-rating of the dredges, has largely remunerated the company for its heavy expenditures. This company is receiving the maximum reduction of 10 per cent allowed for safety and welfare under the merit-rating system, which in itself shows creditable care and attention on the part of the officials of the company for the welfare of its employees.

As stated in an article on the merit-rating system in a previous bulletin by H. M. Wolfin, Chief Mine Inspector, "it will place safety work on a dollars and cents basis and will reward the careful operator and penalize the careless one."

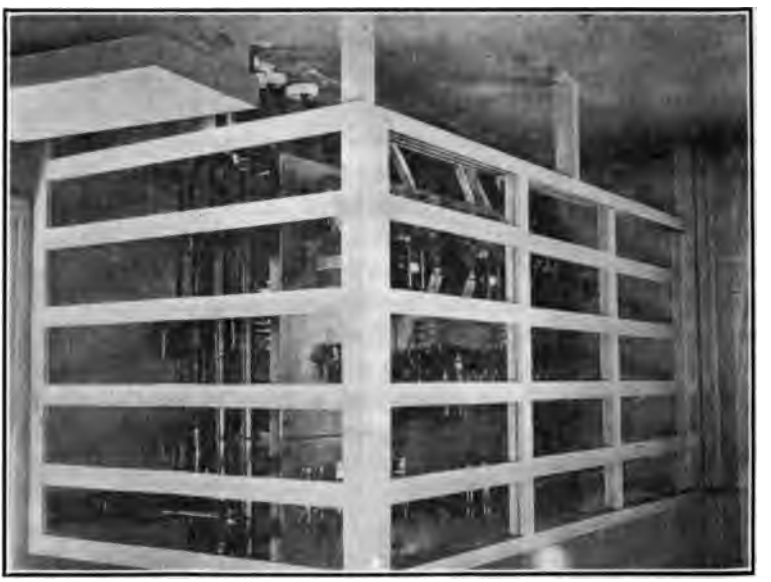
It is therefore necessary for the operators to safeguard their boats if they wish to reduce their insurance rates, for under the merit-rating system, the insurance rates will be reduced if conditions are good, but will be raised above the manual rate if conditions are unsafe.

There are at present 58 gold dredges actively operating in various parts of the state; some of these are very old and are about to be dismantled while new wooden and steel boats are being built. From the point of safety, I might say that the older boats are more difficult to safeguard than those of more recent construction, for the reason that they are lacking in

sufficient space. It is necessary to guard the machinery on these older boats as effectively as possible and considerable ingenuity must be shown in devising guards so that they can be easily and quickly removed to permit necessary repairs to be made.

Character of material for guards.

It has been the custom on many of the older wooden boats to construct machinery and belt guards entirely of wood and, in many instances, these have proved very effective if they have



No. 16 Dredge of Yuba Consolidated Gold Fields showing wooden guard about the switch board in the winch room.

been thoroughly constructed and are not hastily constructed makeshifts. The tendency now is to construct the guards of metal or heavy wire mesh screen. In some instances it seems as if the sheet metal guards are preferable on rapidly moving gears on which thick grease must be used, for the reason that they prevent the grease from flying about, whereas the wire mesh guards would not lend themselves so readily to cleanliness. For pulleys and belts the wire mesh is very useful, as it permits inspection at all times without necessity of removing the guard. In some instances, such as heavy guards under

large heavy belts, wooden planks are used to good advantage, although on some of the later boats these guards are now constructed of steel.

Digging winch guards.

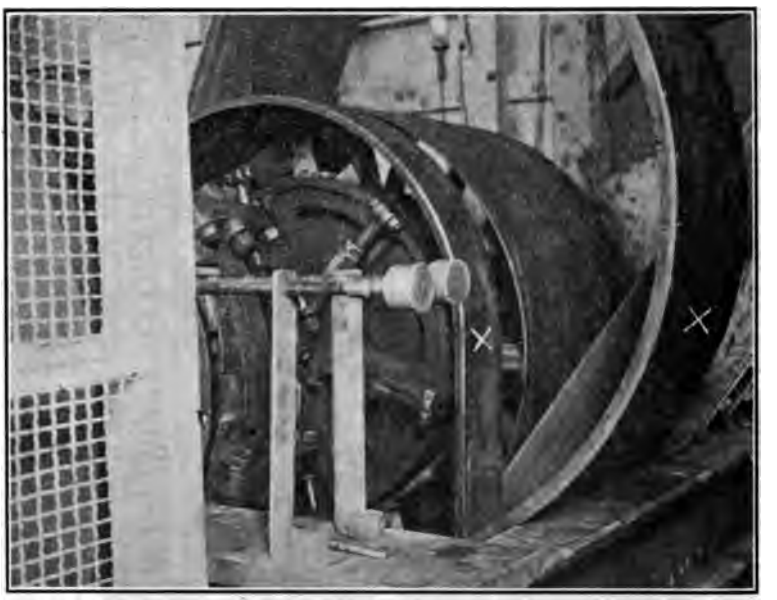
The gear guards for this winch should be constructed of steel and be arranged so that the guard will cover the gears entirely on the outer side from top to bottom, and on the inner side from top to the bearings with a small trap door in the perimeter, for

No. 16 Dredge of the Yuba Consolidated Gold Fields showing heavy wooden latticed guard under the bucket line drive belt.

greasing purposes. All grease cups, where Keystone or similar cups are not used, should be piped out to a convenient place for the oiler to reach without having to stand or reach into the gears to turn them down. The heavy belt for the bucket line drive should have a substantial guard on the under side and edges for its entire length to the upper pulley, to guard against

a whipping blow from the belt in case of the lacing giving way or the belt breaking. Either a wire mesh guard or a two-rail iron or wood railing at least 3½ feet high should extend along each side of the main drive belt, at least 15 inches from the belt. The motor pulley should have a wire screen guard which will extend two or three feet in front of the intake of the pulley to prevent clothing being drawn into the rapidly-moving wheel. A similar guard should be placed on the bucket line drive pulley.

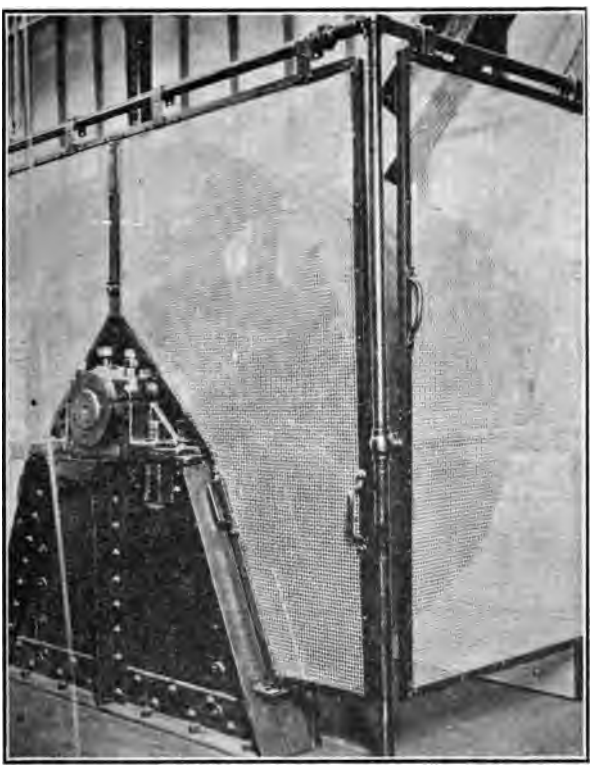
The argument is often made that employees have very explicit orders to shut down any machinery where it is necessary to



No. 1 Dredge of Natomas Company of California. Digging winch, showing clutch guards (X) (one fastened in place at the top and one turned back). Showing also the grease cups piped out to a convenient place for the oiler to reach.

make repairs or turn down grease cups that are in dangerous places, but men have been seen doing this very thing without shutting down, and even passing between the upper and lower portions of the main drive belt of the digging winch when the same was in motion. These practices are, of course, extremely dangerous. The oiler might be discharged for doing these things but would probably get employment elsewhere where he eventually would get killed if the gears and belts were not

sufficiently guarded. A heedless man of this description was recently killed on one of the gold dredges in the state.

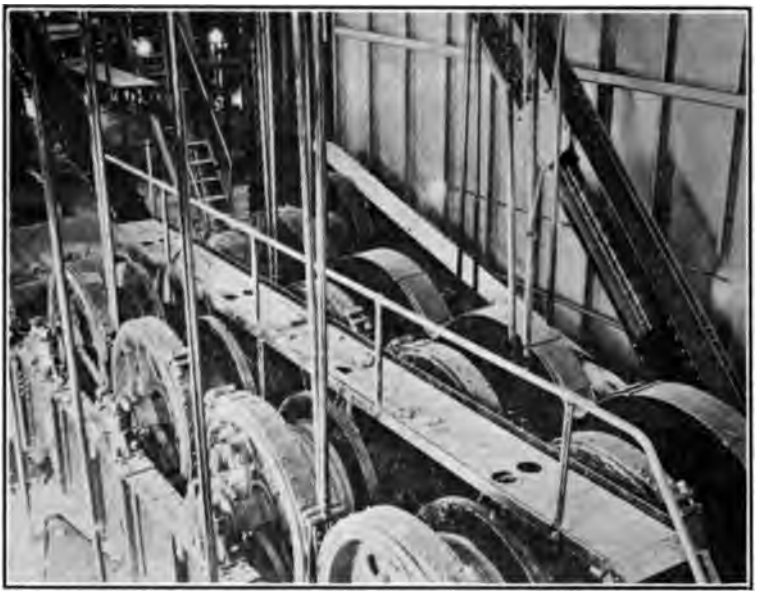


No. 16 Dredge of Yuba Consolidated Gold Fields. Digging winch, showing heavy wire mesh guard over pulley wheel. The pulley wheel guard is held in place by the hooks on the top and fastenings at the sides.

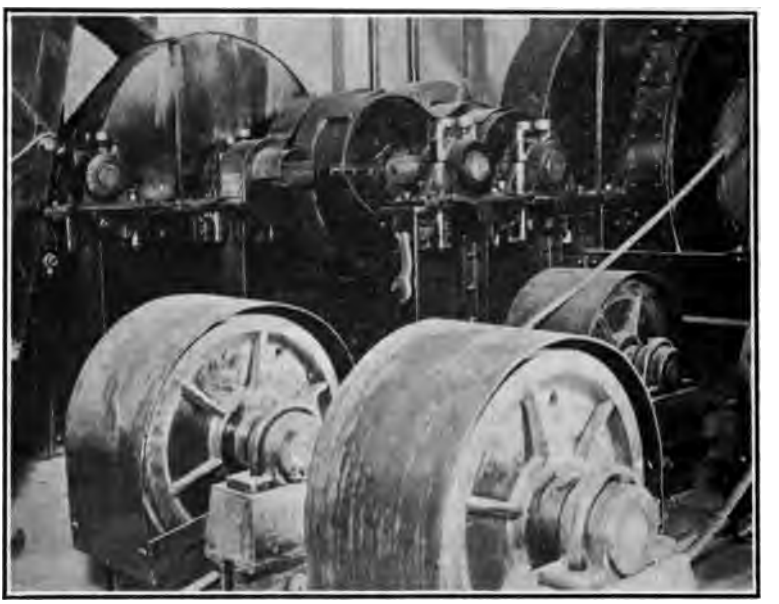
Swing winch guards.

The swing winch gear wheels and pinion wheels should have complete guards from the top to the bottom of the wheels, with openings for greasing purposes and all grease cups on the inboard side of the winch should be piped out or up to a level of the gears, so that the oiler can reach them from the deck or from a platform along the side of the winch.

In many instances, on the newer boats, a platform with railings extends over the winch and the grease cups are piped up to holes in this platform or to one side within easy reach of the oiler. The grease cups on the outboard side are generally



No. 16 Dredge of Yuba Consolidated Gold Fields. Swing winch guards and oilers' platform. Note the holes in the platform for reaching the grease cups and traps in the gear guards for greasing the gears.



No. 16 Dredge of Yuba Consolidated Gold Fields showing guards over the gears of the swing winch.

within easy reach, but in some instances it is necessary to pipe some of them out for better access, especially so when the drive pulley is securely guarded by an elaborate wire mesh guard. In this case the grease cups are generally piped out through the wire mesh of the pulley guard.

The drive pulley for the swing winch should be entirely closed in, with openings for reaching the outer bearing grease cups, and the drive belt protected on its under side and edges with a substantial wooden or steel guard for its entire length.

Upper tumbler drive pulley and gear wheels.

The drive pulley and gear wheels for the upper tumbler have been a means of crippling many men in the past, and the one fatality on gold dredges during 1916 was caused by contact

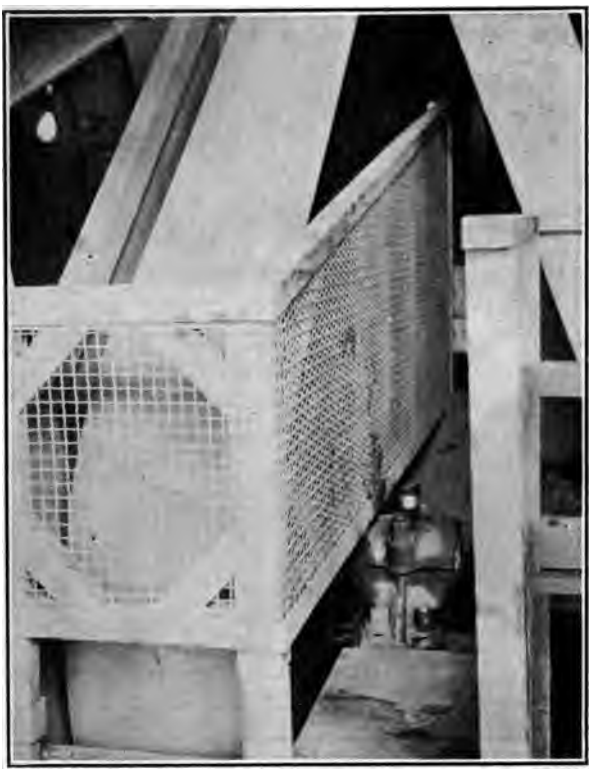
No. 16 Dredge of the Yuba Consolidated Gold Fields showing gear guards for the upper tumbler machinery. Also a screen guard on the inner side of the bull wheel.

with the drive pulley. Other men have been permanently injured in the pinion and intermediate gears.

The drive pulley is now being entirely housed in and all grease cups for the bearings piped through openings in the housing, so that it is not necessary for the oiler to go near the rapidly-moving wheel. If it is necessary to inspect the bearings for possible heating, a guard of metal or wire screen is generally installed between the spokes of the wheel and the bearings. The intermediate gears and pinion wheels for the upper tumbler should be entirely enclosed by a steel guard, with a trap door for greasing purposes or a substantial platform over them and the grease cups piped up to the platform. There should be a complete guard on the inner sides of the bull wheels, from the bearings to the top of the wheel, and a complete platform between the bull wheel and the hopper. All shaft couplings, keys and key seats should be covered over.

Screen drive pulley and belt guard.

The drive pulley for the screen very often is a source of danger to the oiler when he is turning down the grease cups for the tread rollers, thrust and guide rollers and, in the older boats, the space between the pulley and the revolving screen is



No. 1 Dredge of Natomas Company of California. Screen drive pulley and belt guard.

not great, thus necessitating a complete guard on the inner side, and if the pulley is on the lower end of the revolving screen it often is necessary to guard both sides. In cases where the men have to pass under the drive belt it is necessary to install a guard under it also.

Roller guards for screens.

Next to rapidly revolving pulleys, gear wheels and heavy moving belts, the screen tread roller is perhaps the most dangerous piece of machinery on a boat. The tread rollers should

No. 1 Dredge of Natomas Company of California. Port lower tread roller and tread band guard (X), showing grease cups piped out.

be entirely covered over, where exposed to contact, by a guard and the guard extended up over the tread band of the screen, thus preventing all possibility of the oiler being pulled in between the roller and the tread band; such accidents have proved disastrous in the past. Beveled or other gears should be enclosed both top and sides with the necessary opening or trap door for greasing purposes. All grease cups should be piped out to a convenient place.

On the older boats it very often happens that the oiler is in a cramped position when reaching to the grease cups and is

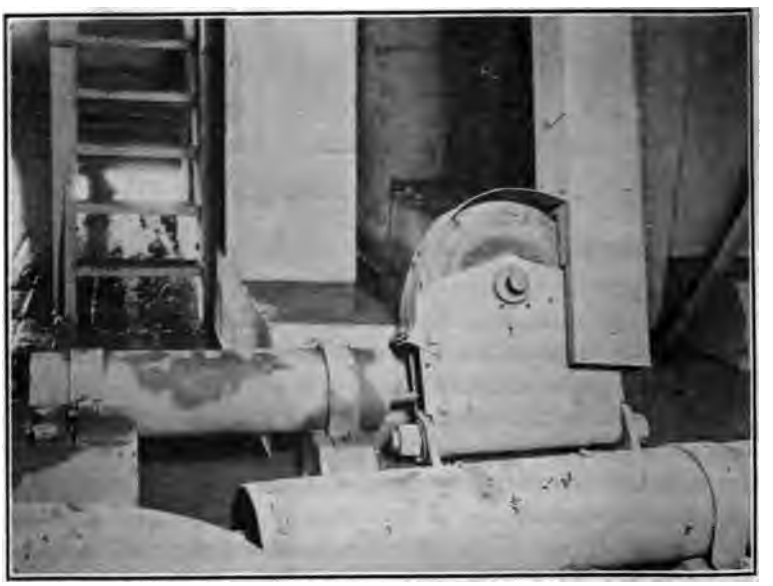
compelled to reach over the tread roller to turn down the cups. Lives have been lost in this manner.

No. 1 Dredge of Natomas Company of California. Starboard lower tread roller and tread band guard (X) and beveled gear guard (XX).

Sheave guards.

Many guards of different kinds are now being used for sheaves on gold dredges, from a simple block of wood nailed to the deck in front of the sheave intake to the more elaborate guards, such as a complete covering of steel or wood. Sheaves with holes cut in the web or with spokes are a source of danger, due to shearing. Fingers are often mutilated by becoming jammed between the web of the sheave and its support. The sheave with smooth web is now coming into favor. For flat deck sheaves lying on the deck it is necessary to install a guard that will prevent the workman's foot from being drawn in by his trousers coming in contact with the sheave and rope. The

No. 1 Dredge of Natomas Company of California. Starboard bow line deck sheave, with iron plate bolted to top side and extending beyond rim of wheel (X).



No 1 Dredge of Natomas Company of California. Deck sheaves for spud lines, showing ropes and sheaves well guarded.

entirely closed-in sheave is the safest where they are intended to be stationary; those that are not stationary may have a very effective guard of sheet iron fastened to the top side, which must extend three or four inches beyond the rim of the wheel.

Stacker belt drive pulley.

On boats where the stacker belt drive pulley is on the outer end and it is necessary to stack very high, there is at times some difficulty caused by slipping of the belt on the pulley, especially so if ice collects on the pulley during the cold

No. 16 Dredge of the Yuba Consolidated Gold Fields. Stacker belt drive pulley, showing guard for the pulley (X) and steel guard completely covering the gears. Note the grease cups piped out.

season. One man recently had his hand, arm and chest crushed while endeavoring to chop the ice from the pulley with a hatchet without first shutting off the power. It is therefore necessary to place a guard in front of the pulley for protection against a recurrence of such accidents. All grease cups for the bearings should be piped out to a convenient place and the gears entirely housed in. The pulley guard can be constructed of iron rods bolted to side pieces or of heavy wire mesh. If wire mesh is used, the mesh must be big enough to permit sand to be thrown through it.

Railings.

In the early days of gold dredging it was a familiar sight to see boats without railings about machinery, stairways, stacker runways, gantry platforms or the sides of the upper deck. The General Safety Orders of the Industrial Accident Commission

No. 1 Dredge of the Natomas Company of California. Railing and toe board about gantry platform. Note the guard over the sheave wheel.

require that railings be provided in these cases. Railings should be at least 3½ feet high and have a second rail between the upper rail and the deck or platform and a toe board about the edges at least six inches high. This toe board is also very necessary about all belts passing through decks or platforms. A very efficient rail and toe board is shown in the accompanying illustration.

Insulation and grounding.

Many of the boats now used in the dredging fields have wet decks and therefore a perfect insulation underfoot is not possible. Lack of space also often creates a hazard by permitting the dredge man to come in contact with wires not properly insulated, thus making a ground connection. All power wires should be insulated or be in conduit, and all start-

ing compensators, conduits and beds of motors should also be thoroughly grounded.

There seems to be a difference of opinion as to what constitutes a perfect ground connection on a dredge. It has been claimed by some that the connection with the steel framework of an all-steel boat is sufficient, while in the case of a boat with a wooden hull, all ground wires should be connected to an iron plate fastened to the side of the boat and extending into the water of the pond. In the case of a boat with a steel hull this may make a perfect ground connection when the spuds are down and the side lines are connected with the bank, but the surest and most approved method advised for both wood and steel boats is to run all ground wires on the boat to the digging and swing winches and the spuds. In cases where wooden spuds are used, the cap and shoe of each spud should be connected by a strip of iron.

Miscellaneous guards.

Among the minor pieces of machinery on a gold dredge may be mentioned drill presses, pump shaft couplings, emery wheels, etc. The gears or other moving parts of these should be covered. Protruding set screws are now being discarded and the counter sunk variety are replacing them.

Life saving devices.

Since accidents are continually happening on gold dredges, it is necessary to provide means of alleviating suffering as well as preventing accidents, and therefore it is imperative that first-aid supplies, including splints and a stretcher, should be within easy reach on all boats.

Instructions for resuscitating men who have received electric shocks or who have become suffocated by falling into the pond should be posted on every dredge and the crew instructed in the method used.

In connection with the danger arising from an unexpected plunge into the pond, a life preserver, with sufficient length of rope attached, is recommended for each boat, also a grappling hook and attached rope for cases where the victim has sunk to the bottom.

SAFETY COMMITTEES.

It has been found that the best results in accident prevention are obtained through safety committees. These are chosen according to the size of the industry, in various ways.

The National Safety Council has outlined what is perhaps the most comprehensive way of introducing a safety campaign:

I.

Necessity for Organization.

The accident prevention problem involves two essential elements—*Safeguarding* and *Education*—in each of which there is more or less detail work. Experience in the past decade has conclusively proven that safeguarding and educational work in any plant is not a "one man job"; that satisfactory results can only be secured through the highest measure of cooperation between the employer and his employees, and this only by means of organization. The employer himself must be vitally interested in the work if he expects to educate his men to share the responsibility with him. The men must be given a part to perform in it, if their interest is to be aroused and maintained. The problem must touch them somewhere, and they must be brought into direct relationship with their employer. It is only through organization that this is possible.

II.

The Work of an Organization.

The form and character of any organization must naturally vary as the work to be performed varies; hence the work to be done by a safety organization should first be considered before determining what the form of organization should be.

Safeguarding and *Education* comprise the task of any safety organization, all of which naturally requires efficient planning, direction and supervision.

In *Safeguarding* there are involved among others the following essential elements:

1. A study of hazards incidental to the use of equipment and machinery.
2. Adoption of standards.
3. Inspection for—
   (*a*) Need of safeguards.

(*b*) Installation of safeguards.
(*c*) Maintenance of safeguards.
(*d*) Use of safeguards.

4. In new construction or replacement, checking in drafting room or purchasing department.

In *Educational* work there are involved among others the following essential elements:

1. A study of hazards incidental to operations.
2. Adoption of operating rules covering safe method of doing work.
3. Instruction of new men as to hazards and rules.
4. Interesting the men.
5. Providing bulletin boards, in the several departments, for the posting of Safety Orders, Rules and Information.

III.

Form of Organization.

The existing working force of every industrial or transportation concern, whether large or small, is adaptable very readily to an accidental prevention organization.

In any form of organization created the following elements are essential:

1. A safety inspector (who in a small plant may perform other duties). He should—
   (*a*) Inspect—
      (1) For need of safeguards.
      (2) For installation of safeguards.
      (3) For maintenance of safeguards.
      (4) For use of safeguards.
      (5) For unsafe practices.
      (6) For plant cleanliness.
   (*b*) Have charge of details of all safety work.
   (*c*) Receive all reports, recommendations and suggestions.
   (*d*) Keep all necessary records.
2. A central committee of safety composed of plant superintendent or his assistant (chairman), safety inspector (secretary), and three or more high grade department superintendents, foremen or workmen, which should—
   (*a*) Have general charge and supervision over safety work.
   (*b*) Pass on all matters of controversy.
   (*c*) Gather all available information.

(*d*) Establish standards for safeguards.
(*e*) Promulgate rules for safe operation.
(*f*) Outline educational campaign.

3. Workmen's committees; consisting of three to five workmen, appointed and changed periodically. They should—
   (*a*) Make inspections.
   (*b*) Investigate accidents in their several departments.
   (*c*) Render written reports on forms provided for that purpose.
4. Foremen: Each foreman should—
   (*a*) Enforce safety rules adopted.
   (*b*) Be held responsible for the safety of his men.
   (*c*) Investigate accidents, reporting causes and suggestions for method of preventing recurence on forms provided for that purpose.
   (*d*) Make frequent inspections of his department.
   (*e*) Render weekly written reports on forms provided for that purpose.
5. Meetings of foremen—held monthly to discuss safety matters.
6. Workmen: Each workman should be educated and interested in safety matters. This work involves—
   (*a*) Instruction of new men.
   (*b*) Familiarizing of men with rules.
   (*c*) Interesting the men through bulletin boards, prizes, etc.
   (*d*) Discipline.

In smaller plants and factories the development of the workmen's interest in safety and the utilization of his power of safety inspection can doubtless be obtained by a much simpler committee system.

LIST OF SKETCHES OF SAFETY DEVICES.

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California gold dredge operators. It is impossible to fill requests for complete sets of these drawings. In asking for the drawings which you desire, please refer to them by number.

1—Arm and Leg Splints.
6—Automatic Switch to Operate Colored Signal Lights.
25—Metal Stretcher.

28—Belt Shifter on Lathe.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
38—Stretcher Drill Diagram.
41—Guard for Rip Saw.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

How to Splice Wire Rope (Illus.).
Locked Signal System (Illus.).
Raising a Gin Pole (Illus.).
Emergency Pipe Wrench (Illus.).
Water-tank Indicating Gauge (Illus.).

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BULLETIN No. 6

Merit Rating California Mines

FOR

Compensation Insurance

JUNE, 1917

Issued by the
Industrial Accident Commission
of the
State of California

In Cooperation with
United States Bureau of Mines

Criticisms and Suggestions Invited Prior to July 15, 1917

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Acknowledgment is made of the courtesy of Mr. H. M. Wilson, who permitted the use of the Coal Mine Merit Rating Schedule and Standards of the Associated Companies, in the preparation of the schedule printed herein. Acknowledgment is also made of the assistance rendered by Mr. Wm. Leslie, of the State Compensation Insurance Fund, and Mr. Edwin Higgins, Consulting Mining Engineer, who did much of the work of preparing the schedule and standards.

MERIT RATING CALIFORNIA MINES FOR COMPENSATION INSURANCE.

By H. M. Wolflin.

As was mentioned in Bulletin No. 4, an effort is being made to have California Metal Mines merit rated for compensation insurance. Under this scheme unsafe mines will pay a higher rate of insurance than those that have safer conditions and employ safety organizations working to prevent accidents. The Insurance Commissioner of the State has expressed himself as being favorably inclined toward the idea of merit rating mines, so it now remains to devise a just and equitable schedule under which the merit rating may be done.

In the following pages will be given an outline of a schedule which has been modeled after the coal mine schedule of the Associated Insurance Companies. After conference with mine operators and mining engineers, the schedule given herein was prepared by Edwin Higgins, Consulting Mining Engineer, William Leslie, of the State Compensation Insurance Fund, and the writer. It is perhaps incomplete; in any event is only tentative, and is submitted for the purpose of securing from those interested, suggestions for changes which will make the schedule more applicable to conditions actually encountered in California mines.

To a considerable extent, this scheme of merit rating puts mine safety work on a dollars and cents basis. Recognition is given the safety work and safety conditions at any mine, and these factors are rated so that the insurance rate to be paid will depend quite largely on conditions at the mine. Instead of demanding that all minor precautions must be observed, the schedule leaves to the judgment of the operator the decision as to whether certain precautions shall be regarded; if regarded, the rate is reduced; if disregarded, the rate is correspondingly increased.

The proposed schedule is divided into ten main divisions, each of which is given a certain percentage rate, or weight, as follows:

I.	Safety organization, inspection service and education	25 %
II.	Safety measures	15 %
III.	Falls of rock or ore	15.1%
IV.	Explosives	10.6%
V.	Haulage underground	1.7%
VI.	Falls of persons down chutes, raises, winzes, etc.	4.5%
VII.	Electricity	0.7%
VIII.	Miscellaneous underground hazards	10.4%
IX.	Shaft hazards	9.8%
X.	Surface hazards	7.2%
		100.0%

Under each main heading there are various subdivisions, each having its respective weight, as will be shown subsequently. The weights of the main divisions have been computed from experience in a large number of accidents that have occurred in California during the past few years. Some consideration has also been given to experience in other mining states where conditions are similar to those which exist in California. Under each of the ten main headings it is possible for a mine in the poorest condition to receive as many as 100 demerits when the schedule is applied. The mine with perfect safety conditions would not receive any demerits, while the one with average California conditions would receive 50, or some other predetermined number of demerits, under each heading.

Referring to the schedule, it will be noted that under the first heading, "Mine Inspector's Record," certain general information is required. This is for the files of the insurance carrier and has nothing to do with the merit rating. Following the rating schedule proper is a schedule showing the increase in the rates effective as the distances increase to sources of medical or surgical aid. These charges are entirely independent of the merit rate. By medical or surgical aid in this schedule is meant a licensed doctor or surgeon capable of caring for injured workmen.

Under the heading "Tentative Mine Safety Standards," subdivisions and numbers correspond to those of the merit rating schedule. Under each subdivision is given a brief outline of the condition which must obtain in order for the mine in question to receive no demerits under said subheading.

MINE INSPECTOR'S RECORD.

GENERAL INFORMATION.

Name _____
Post-office address _____
Inspector _____ Date of inspection _____
Name of operating company or person_____
Post-office address _____
Name of the owner, firm or corporation_____
Post-office address _____
General manager or general superintendent_____
Post-office address _____
Name of mine_____ Location_____
Entrance to mine (by vertical shaft, incline shaft, tunnel or adit. If incline shaft, state if in vein or hanging or footwall, and give inclination) :
_____
_____
Entrance to mine: Number_____ distance apart_____
Kind and texture of country rock_____
Nature of deposit (fissure vein, fissured zone, replacement in limestone, contact, disseminated in sediments, gravel) :
_____
hief ores mined_____ gangue material_____
verage thickness of deposit_____ strike_____ dip_____

l and nature of—hanging wall_____ footwall_____
iod of mining_____
_____
e various classifications of work engaged in and average number of men in each
_____

I.

*ty organization, inspection service and education*_____ 25%

Organization:

1. Interest of superintendent and staff (exclusive of foremen and shift bosses) in safety work_____ 4
2. Ability and interest of foremen, assistants, and shift bosses in safety work _____ 4
3. Number of underground men per shift boss_____ 2
4. Discipline: Is it enforced and observed_____ 6
   a. By mine officials_____ 3
   b. By mine employees_____ 3
5. General safety committee_____ 20
   1. Fitness of personnel of safety committee_____ 3
   2. Frequency of meetings_____ 6
   3. Are written records kept of such meetings_____ 5
   4. Responsibility and activity of such committee_____ 6
6. Mine inspection committee_____ 18
   1. Fitness of personnel_____ 5
   2. Are written reports of inspections made_____ 3
   3. Is membership of such committee changed at regular intervals_____ Describe_____ 4
   4. Frequency of inspections by mine committee_____ 6

Inspection service _____ 21

1. In addition to A (organization), what inspection service is provided_____ Are records of inspections complete_____ Frequency of inspections _____ Is all special equipment, such as cables, hoisting apparatus, high pressure boilers, etc., regularly inspected in addition to inspections of working places, etc._____ Are records kept of such inspections_____ Are the causes of all accidents investigated_____ Are recommendations made to prevent the recurrence of other accidents in same manner_____12
2. Adequacy and efficiency of inspection records, embraced in such additional service _____ 3
3. Investigations of accidents and recommendations to prevent recurrence _____ 6

Education _____ 25

1. Are "Rules for Underground Men" issued as required by Mine Safety Rules? (Inspect records of distribution in mine office files)_____ 3
2. Safety bulletin boards, safety leaflets, number and location or method and frequency of issue. (Secure and submit copy of leaflets, bulletins, etc.)_____ 6
3. Suggestion box: Are prizes given for good safety suggestions? Are good suggestions given consideration and acted upon_____ 4
4. Bonuses for safety: How and in what amount and how frequently distributed _____ 4
5. Safety meets, rallies, lectures; character and frequency of_____ 8

Total _____ 100

II.

Safety measures ---------- 15%

1. Warning, miscellaneous and danger and direction signs; permanency, legibility and frequency of; surface---------- underground---------- 6
2. Artificial breathing apparatus: Number of sets---------- Are they kept in a readily accessible place---------- If supplied by a cooperative station, how far removed from mine---------- Is telephone communication maintained between mine and station---------- Are equipments inspected---------- How frequently---------- By whom---------- Are written records kept of such inspections and tests---------- Are men properly trained to use the apparatus ---------- How many---------- How many men so trained are allowed underground at one time---------- How frequently do trained men practice---------- 10
3. Telephones: Number outside---------- Number inside---------- Location and completeness of service---------- Can doctor or hospital be reached---------- 4
4. First aid ---------- 16
   - *a.* Organization and training: Number of trained men----------
     Frequency of practice---------- 8
     Efficiency of organization---------- 8
   - *b.* Equipment ---------- 14
     Condition and amount of supplies---------- 7
     How are first-aid packets issued---------- 2
     How and where are supplies kept, underground---------- 3
     On surface ---------- 2
5. Wash and change houses---------- 8
   - *a.* Number of basins---------- Number of showers---------- 2
   - *b.* Toilet, sewerage and water supply---------- 2
   - *c.* Janitor service, character of---------- 1

     Towel supply ---------- 3
6. Liquor: Convenience and restrictions on use---------- 5
7. Hospital or its equivalent---------- 18

   Distance from mine in miles---------- Distance from mine in time ----------10

   Facilities: Surgeons---------- Nurses----------

   Beds ---------- Equipment---------- 8
8. Illumination ---------- 8
   - *a.* By miners' lights; safety, brilliancy, distribution and convenience while working and traveling---------- 4
   - *b.* By electric lights at shaft stations, skip pockets, magazines, escapeways, etc. ---------- 4
9. Checking in and out system---------- 3
10. Condition of escapeways or exits for use in emergencies---------- 5
11. Condition and illumination of runarounds at shaft stations, skip pockets and other dangerous places and on haulage ways, etc.---------- 3

Total ---------- 100

III.

Falls of rock or ore---------- 15.1%

A. Shaft stations ---------- 5

1. Average size ----------
2. Chief sources of danger----------
3. Is timber required----------; if so, is it supplied and effectively used ----------
4. Frequency and adequacy of inspection----------

B. Drifts and crosscuts, including working faces of same ____ 35
1. Danger from falling of small pieces of rock ____ 5
2. Danger from falling of slabs or masses of rock ____ 10
3. Method and adequacy of timbering ____ 10
4. Inspection: By whom ____ Frequency ____
Adequacy ____ 10

C. Stopes and other working places ____ 60
1. Danger from falling of small pieces from back (roof) or walls ____ 5
2. Danger from falling of small pieces from back (roof) or walls ____ 25
3. Method and adequacy of timbering (close enough to face) ____ 15
4. Method and adequacy of filling ____ 5
5. Inspection: By whom ____ Frequency ____
Adequacy ____ 10

Total ____ 100

IV.

Explosives ____ 10.6%

A. Kind of explosives ____
B. Surface magazines ____ 5
1. Distance from nearest mine entrance ____
2. Distance from nearest building ____
3. Safety of method of storing and handling explosives in magazine ____
4. How and of what material is magazine constructed ____
5. Position of magazine—sheltered, exposed ____
6. Other material stored in magazine ____
7. Storage of caps ____
C. Transfer of explosives to mine ____ 10
1. Frequency of transfer from surface magazine to underground ____
2. Method of transfer—with men, supplies, machinery ____
3. Explosives delivered to underground magazine or direct to working faces ____
D. Underground storage of explosives ____ 20
1. Number, construction, underground magazines ____ 2
2. Magazines, close to shaft station, pump station, or on main traveling way ____ 3
3. Possibility of men reaching shaft in case of explosion in magazine and possibility of gases passing out through stopes where men are working ____ 3
4. Storage of caps and fuse (with dynamite) ____ 4
5. Cleanliness of magazine (fire danger), illumination ____ 3
6. Connection with timbered workings (fire danger) ____ 2
7. Are magazines kept locked ____ Who has keys ____ 3
E. Transportation of explosives to working places ____ 15
1. Are explosives delivered to miner at magazine ____
At working place ____ Miners allowed to enter magazine, secure explosives and carry to working place ____ 8
2. Method of carrying dynamite to working place (with caps) ____ 7
F. Thawing ____ 5
1. Supervision of whom ____
2. Method ____

G. Loading and shooting 20
1. Method of capping fuse and making primers (fuse should not be less than 40 inches) 5
2. Material used for waterproofing cap and fuse joint 2
3. Method of loading drill holes before loading 2
4. Loading of holes—By whom ..... Position of primer in hole ..... Kind of bar used 4
5. Hours for shooting 2
6. Method of warning before shooting 1
7. Number of holes "fired" by one man 3
8. Method of shooting (cap and fuse—battery) 1
H. Misfires 5
1. Method of reporting .....
2. Method of finding and handling—by whom .....

Total 100

V.

Haulage underground 17½

A. Haulage system: Hand trimming, animals or mechanical 15
Condition of equipment .....
Collision hazard .....
Single or double track .....
Block signals .....
B. Locomotives: Electric trolley, storage battery, gasoline, compressed air—number and make of each 12
Animals .....
Rope haulage—condition of pulleys .....
Tension of carriage rollers .....
Cars—capacity ..... Number per trip .....
Condition of body and running gear .....
C. Brakes on cars: Kind and convenience of 15
Hazard due to grades .....
Hazard due to derailment .....
D. Clearance between loaded cars and roof .....
Between car sides and timber .....
From top of cars to trolley wire .....
E. Illumination of haulage ways: Kind .....
F. Condition of track ..... Weight of rails .....
Joint fastenings ..... Size and kind of .....
Ties .....
G. Condition of roadbed ..... Loose material .....
Soft or hard ..... Smooth or rough .....
Wet or dry .....
H. Chutes: Clearance .....
I. Jumping moving cars .....
Uncoupling moving cars .....
Riding cars without brakes .....
J. Shelter holes or spaces: Necessity for .....
Frequency of .....

Total .....

VI.

ls of persons down chutes, raises, winzes, etc.	4.5%
. Chutes and bins:	
Condition of opening	
Protection against falls, etc.	25
. Raises and winzes:	
Inclination	
Wet or dry	
Condition of	
Ladderway	
Protection at collar of manways and winzes	50
. Open places:	
Possibility of walking into	25
Total	100

VII.

:tricity	0.7%
Character of electrical installation	20
1. General safety precautions	10
2. Condition of lightning arresters	2
3. Condition of fire fighting equipments and knowledge of use	5
4. Accessibility of equipment	3
Trolley wire	15
1. Voltage (300 or less)	5
2. Protection—height above track; guards	2
3. Special protection at chutes, etc.	3
4. Adequacy and permanency of supports	2
5. Protection from other contact hazards; control of trolley circuits; grounding; are drawbars and axles bonded; condition of rail bonds	3
Stationary motors: Pumps, hoists, fans	15
1. Illumination of moving parts	2
2. Exposed live controller contacts	5
3. Unprotected motor terminals	5
4. Unprotected slip rings	3
Transmission lines and cables, including illuminating circuits: Underground transformers, etc.	40
1. Voltage (300 or less)	5
2. Improperly fused out cuts (fused too high)	5
3. Poor alignment of switch parts	2
4. Excessive adjustment of circuit breakers	5
5. Interruption of ground circuit, from cases of motors, transformers, oil switches, starting boxes and rheostats, compensators	5
6. Illuminating circuits, condition	5
7. Worn insulation	3
8. Bad cable armor	3
9. Excessive sag between supports	1
10. Loose supports of wires or cables	4
11. Unsoldered joints	2
Miscellaneous	10
Total	100

VIII.

Miscellaneous underground hazards 10.4%

A. Transporting and handling timber and other materials:
Are materials handled carefully.....
Are same placed carefully..... 20

B. Run of ore from chutes or pockets:
Are chutes equipped with approved types of doors.....
What other precautions are taken in drawing ore or rock.....
..... 10

C. Drilling hazard:
How are drilling machines set up.....
How run .....
Does method present a minimum hazard.....
Are all dangerous parts of machines properly and adequately guarded.... 15

D. Machinery and miscellaneous tools (not including locomotives or drills):
Is all miscellaneous machinery properly guarded.....
Are tools in first-class shape..... 16
(Heads of hammers, sledges, drills, etc., to be in good condition and not mushroomed.)

E. Mine fires:
Is there adequate fire protection at shaft collar.....
Is water available at dry shaft stations.....
Is water available in dry timbered cross cuts, drifts or other working places 10

F. Suffocating from natural gases or powder gases after blasting:
Do natural gases exist in mine.....; if so, what precautions are taken to prevent its injuring men.....
Is such precaution sufficient.....
How are gases removed from "dead ends" after blasting.....
Are men allowed to return before gases are removed.....
What means are taken to prevent the men returning..... 8

G. Inrush of water:
Are all openings protected against possible inrush due to cloudburst or flood .....
Is protection adequate.....
Describe .....
Are any of the workings under ditch, river, lake or other body of water.....; if so, what precautions are taken to prevent flood .....
Are any abandoned workings flooded.....; if so, is a proper barrier maintained between working face and the abandoned workings?
Are bore holes driven when approaching abandoned workings..... 1

H. Are turned-up nails left about.....
Are there any other dangerous conditions or practices (cover fully)..... 20

Total 100

IX.

Shaft hazards 9.8%

A. Headframe: Strength and construction..... 5
B. Hoisting engine: Kind and condition; indicator; brakes.
Overwind device 20
C. Cable: Condition; inspection; size; lap on drum..... 15
D. Gates: Bars or chains at shaft collar and stations..... 10

Hoisting and lowering men	30
1. In cage with safety catches; condition	3
2. In skip—bonnet; overloaded; safety catches	8
3. Guides and tracks—condition; inspection	8
4. Danger of wreck from moving ground	5
5. Danger from fall of rock from wall plates	2
6. Crowding of men on stations at end of shift	4
Ladderway: Condition; inspection; wet or dry	5
Protection of men at skip pockets	7
Hoisting signals and devices: Adequacy and safety	8
Total	100

X.

face hazards	7.2%
Extent of power: Hoisting and mechanical equipment	
1. Efficiency of governor—guards on exposed moving parts of machinery; boiler inspection; hazard due to exhaust steam	
2. Protection of compressors	8
Other machinery, dumping and loading appliances, pumping plant, blacksmith, machine and carpenter shop	
1. Are guards and warnings on exposed moving parts	15
Cleanliness of yards and buildings	6
Chutes and bins: Ventilation and guarding of	8
Electricity: Voltage	
Dangerous conditions and protection	
Safety and permanency of installation and wiring	
Substation, guards and warnings	5
Illumination for building: Quality: distribution	5
Surface haulage: Type Stop blocks, derails	
Clearance alongside obstructions	
Safety of brakes, coupling or chains	
Do men ride trains	15
Escape or refuge—way for men at bottom of inclines, etc.	5
Railway: Safety warnings Clearance	
Obstruction alongside of track	
Condition of track	
Grades	
Method of handling cars at ore bins	10
(a) Floors: Condition of Loading of	
Protection to openings	3
(b) Stairways: Condition of	
Treads and hand rails	3
Fire protection: fireproof construction of buildings	
Automatic sprinklers for inflammable buildings	
Fire exits and stairways from high structures	
Fire alarm and drills	
Location and condition of water plugs, hose and nozzles	
Water supply	6
Falling objects: Hand tools	
Handling timber and other supplies	4
Miscellaneous surface hazards	
Ground openings Runways	
Obstruction in buildings or passageways	
Teaming and construction	
Other	7
Total	100

Distance From Medical Aid.

Omitting entirely the increase in the cost of compensation on account of the remoteness of a mine from a source of medical and surgical attention, there is nevertheless a very material increase in the cost of furnishing medical, surgical and hospital services on account of such remoteness. To compute this added cost accurately is quite impossible, but the following table furnishes a satisfactory basis on which to work and though an undercharge, if anything, is better for the insurance carriers than the present plan of making no change in the rate regardless of the location of the mine with respect to medical or surgical aid. The charges, being under rather than over, work no possible injustice on the mine operator.

Distance to sources of medical or surgical attention—	
3 miles—increase in rates	3%
4 miles—increase in rates	4%
5 miles—increase in rates	5%
6 miles—increase in rates	6%
7 miles—increase in rates	7%
8 miles—increase in rates	8%
— miles—increase in rates	—%
— miles—increase in rates	—%
30 miles—increase in rates	30%

That these increases are undercharges may be shown in the following manner:

A mine four miles from medical aid has a man injured—the ordinary fee for first visit is $2—but in this case the doctor is allowed $4 ($2 extra for mileage) or an increase of 100 per cent. As medical, hospital, etc., represents 15 per cent of the gross premium, this increase on account of mileage would be 15 per cent. Of course certain items entering into the 15 per cent cost of medical, hospital, etc., would not be increased in like degree and possibly many cases would be sent or brought to the doctor at the company's expense, thus reducing this increase somewhat below 15 per cent. However, a 4 per cent increase is obviously extremely low.

Each insurance carrier must ascertain the distance from the mine to a source of medical and surgical aid and increase its rates in accordance with the above table on the basis of this information. This is to be done regardless of the merit rating of the mine.

TENTATIVE MINE SAFETY STANDARDS.

General.

In all cases the requirements of the Mine Safety Rules, Electrical Utilization Safety Orders, General Safety Orders, Boiler Engine and Air Pressure Safety Orders, Logging and Sawmill Safety Orders, Wood Working Safety Orders and other requirements and orders of the Industrial Accident Commission, should be complied with or else the risk should be penalized, unless the Industrial Accident Commission has granted exemption to the said rules or orders.

I. Safety Organization, Inspection Service and Education.

A. *Organization.*

1. Superintendent: The superintendent shall take an active interest in accident prevention and see that all the mining laws of the State and the rules and recommendation of the Industrial Accident Commission are complied with. He shall endeavor to have the recommendations of his own safety inspector carried out promptly; to have an accurate record kept of all accidents; and he shall encourage the miners to apply for first aid and medical treatment when injured. At least weekly he, or some one designated by him, shall inspect all portions of the mine.

2. Mine Foreman: The mine foreman or his assistants or other competent persons authorized by him shall inspect all working places, haulage roads and traveling ways at least twice daily, and in any case in compliance with the Mine Safety Rules. In mines with dangerous conditions, such inspections shall be made oftener if in the judgment of the Industrial Accident Commission Inspector more frequent inspections appear necessary.

3. The number of men per shift boss may vary somewhat, according to local conditions, but it should not exceed _____ men in any case, unless all the men are working very near together.

4. Discipline: Discipline shall consist in obedience to orders and compliance with the rules of the mine, the rules of the Industrial Accident Commission and the mining laws of the State. It shall be judged as it appears in the conduct and performance of duty by the officials and mine employees.

a. Mine Officials: The efficiency and discipline of the personnel shall be judged largely by the general order, neatness and cleanliness of the buildings, shops, yards, and underground workings, disposal of oily waste and scrap, old refuse, the piling of material and the like. By the inspection of working places, and as reflected in the number of accidents, their treatment and recording; the condition of first-aid supplies and the general sanitary condition of the mine. By inspection of old workings, condition of drainage, ventilation, timbering, etc.

b. The discipline and carefulness of mine employees shall be judged principally by violation of mine rules, method of transporting and storing explosives underground, firing of shots, by the timbering of working places, leaving working places during working hours to loaf around sidetracks or switches, traveling motor roads unnecessarily, jumping moving cars, skips or cages, and doing other things liable to cause accidents.

5. General Safety Committee: 1. A general committee of not less than three persons shall be selected from the following: Manager, superintendent, assistant superintendent, mining engineer, master mechanic, foreman or heads of departments. The committee shall be composed of men of exceptional fitness for safety work, who are interested in the reduction of accidents.

2. Meetings shall be held once each calendar month at such time as the mine superintendent or secretary of the committee shall direct.

3. Written records shall be kept of all meetings of the General Safety Committee.

4. This committee shall:

First. Review and approve inspection reports.

Second. Pass on all safety recommendations to determine their practicability, and for this purpose meetings shall be held at intervals of not more than one month and written records of such meetings shall be kept.

Third. Familiarize themselves with the cause of all accidents for the purpose of devising methods which shall tend to eliminate similar accidents.

Fourth. See that new employees are properly instructed as to the hazards of their work, and that employees of the different departments are educated in safety practices through the use of bulletins, printed rules and oral instructions.

Fifth. Supervise safety inspection work.

6. Mine Inspection Committee: 1. There shall work in conjunction with the General Safety Committee a Mine Inspection Committee, consisting of not less than three workmen. The personnel of this committee shall be changed at regular intervals, preferably by rotation, and shall be chosen from among men of considerable experience, who are interested in accident prevention.

2–3. Written reports of inspections shall be made, and the membership of the committee shall be changed at regular intervals, preferably by rotation. Such written reports shall be signed by the members and submitted, together with recommendations for safeguarding or precautions which are considered desirable, to the General Safety Committee.

4. The Mine Inspection Committee shall make no less than one *thorough inspection* of the mine each month.

B. *Inspection Service.*

1. At mines employing less than 200 men, the duties of safety inspector shall be assigned some experienced employee who preferably has had some training concerning mine safety. If more than 200 men are employed the employee-inspector before mentioned shall work in conjunction with a mining engineer experienced in mine safety work. The duties of this inspector shall be as follows:

1. Follow up general lines of outstanding safety work and keep records of same.

2. Make general inspection at least monthly of each working place, of all surface and underground workings and keep records of same. He shall make written recommendations for necessary safeguards or safety precautions.

3. He shall make or arrange for regular inspections of special equipment, such as cables, hoisting apparatus, high pressure boilers, etc., and shall keep written records of each inspection.

4. He shall preferably have charge of first-aid supplies and safety stations, take charge of the safety and rescue training, see that the supplies are in order and train with the men. He shall keep records of all inspections, improvements, recommendations, and meetings of safety committees. These records shall be available for examination by the inspectors of the Industrial Accident Commission, the insurance carrier and the Merit Rating Bureau.

2–3. Complete inspection records shall be kept by the safety inspector, who shall report on all accidents, shall serve as secretary of the General Safety Committee, keep records of safety suggestions and accidents, record cases of gross carelessness and wilful misconduct that come to his notice, whether or not such cases cause accidents. He shall make recommendations to prevent the recurrence of accidents and shall keep a record of such recommendations, which record shall be available for examination by the inspectors of the Industrial Accident Commission, the insurance carrier, and the Merit Rating Bureau.

C. *Education.*

1. Mine Rules: The requirements of sections 15 and 16 of the Mine Safety Rules shall be fully met, particular care being taken that all underground employees carefully read and understand the Miscellaneous Rules before signing the same.

2. Safety Bulletin Boards: Safety bulletin boards shall be provided at all mines. Safety bulletins or special safety rules, pictures, slogans, circulars, or news items shall be posted on such bulletin boards. These shall be changed from time to time, at least weekly. Some means of disseminating safety information among the miners should be provided. This may be by means of safety leaflets, special safety rules printed on

the pay envelopes or duebills, or such other means as the operator may elect, but it must be efficient and of a kind to give the results sought.

3. Suggestion Box: There shall be at all mines a suggestion box in which employees are invited to deposit suggestions for safety, due credit to be given for any suggestion accepted and acted upon, and a small bonus shall be paid to the person making the suggestion.

4. Bonuses for Safety: In addition to the suggestion box there shall be at all mines some means of providing an incentive for safety. This may be by means of bonuses paid for accident prevention or by some other equally efficient method which the operator may devise.

5. Safety Meets, Lectures and Rallies: Where 50 men or more are employed there shall be either safety meets, or rallies, or illustrated lectures, or moving pictures relating to safety; an effort being made to have at least two of these of a different form each year. These shall be open to all employees and efforts shall be made to interest the non-English speaking employees. Where there are groups of mines they may hold collective meetings or rallies. Each participating company shall post notice of such meetings, and the smaller companies should arrange to join in with the larger companies to the end that a general interest and division of expenses may be had. In isolated sections the local doctor or the safety inspector may carry on this work in conjunction with the superintendent, foreman or others. The giving of addresses or participating with the miners in general round-table conferences relative to safety in their lines will be considered as compliance with these standards.

II. Safety Measures.

1. Signboards: Substantial and legible danger and direction signboards and warnings shall be posted in all mines. These should be of permanent nature and shall be posted at electrical hazards, switches, openings to old workings, other dangerous places, and at escapeways. They should conform to approved safety symbols. The symbols or wording shall be easily comprehensible to foreign speaking miners. The following signs are those most generally adopted, viz: for caution a green rectangle on a white ground; for danger a red circle on a dark ground; and to point the way to safety a white arrow on a dark ground. Direction signs should point the way to safety exits, escapeways and manways. There shall be similar posting of signs at dangerous places on the surface, at the top and bottom of inclines, railroad crossings, points of scant clearance, at the magazine, power plant, electrical hazards, chutes, etc. The presence of a danger or warning sign shall in no case be considered sufficient precaution if the hazard covered by it is such that it can be removed. Care shall be taken that the danger *sign shall not be* used promiscuously. The intent shall be that a danger

sign means "stop," while a caution sign shall mean "proceed with caution."

2. Artificial Breathing Apparatus: The requirements of section 5, Mine Safety Rules, shall be fully met unless an exemption has been issued by the Industrial Accident Commission.

3. Telephones: In addition to section 57 of Mine Safety Rules, the following should be observed:

All mines should have telephonic communication with the nearest doctor and with the cooperative mine rescue station, if any. In all mines employing more than 50 men or in which any working place is more than 1,000 feet distant from the shaft station or from the entrance to the drift or slope, a telephone system should be installed with telephones located at convenient points in addition to those designated in the following:

One telephone should be located on the surface, preferably in the office or engine room—one at each shaft station, and if, in the judgment of the Industrial Accident Commission, it is necessary, one should be placed in each section of the mine in which men are working. The telephones inside the mine shall be of an approved type of underground telephone installed in a workmanlike manner, and maintained in good condition. The code of telephone calls shall be posted at each instrument.

4. First Aid: The provisions of section 4 of the Mine Safety Rules should be fully complied with, and, in addition, the following should apply:

For mines employing from two to ten men, there shall be provided a stretcher, a blanket and a first-aid cabinet with contents similar to those of the standard cabinets approved by the Bureau of Mines or the American Red Cross; and at least two men shall be trained in the use of same.

For mines employing from ten to fifty men, there shall be kept on the surface an approved first-aid cabinet, a stretcher, a woolen blanket, and a waterproof blanket; all supplies to be suitably protected from air and moisture. There shall be additional stretchers, blankets and first-aid supplies inside the mine in locations readily accessible from all parts of the mine.

For mines employing more than 50 men there shall be kept, in an accessible place on the surface, supplies similar to and protected as above. There shall also be kept underground blankets, stretchers and first-aid supplies, suitably protected from air and moisture, at such locations in the mine as to be readily accessible; one of these underground stations being conveniently located for each 50 underground men employed. At least one man in every 10 employed shall be trained in first-aid and shall carry, when at work, an approved first-aid *packet.*

For every 100 employees or fraction thereof a first-aid team of five men shall be organized in accordance with recognized standards. There shall be provision for practice of such first-aid teams at intervals not exceeding two weeks.

All officials, including members of the engineering corps, should be trained in first-aid, and should carry when at work, approved first-aid packets. In mines where motors are used for haulage, first-aid supplies should be carried on each motor.

5. Wash and Change House and Sewerage: When the wearing apparel of any of the mine employees may become wet or where a number of men must walk or ride in open conveyance to their homes, the owner should provide a convenient building suitably heated for such mine employees to change their clothing. This room should be equipped with a sufficient number of showers and basins—showers and basins to be furnished with hot and cold water—to accommodate all employees. There should also be a ventilated metal locker or ceiling hook with raising cord or chain and pulley for each workman for the safekeeping of his clothes. Where a majority of the mine workers make request for regular bathing facilities, the owner or operator should furnish the same. Efficient janitor service should be provided for the change house. Clean towels that have been boiled since they were last used should be furnished by the employer.

At all mines there shall be provided on the surface one or more sanitary toilets as conditions may require. Precautions shall be taken to keep all portions of the underground workings where men work or travel in a sanitary condition, and toilets should be provided at convenient places.

6. Liquor: The superintendent and other mine officials shall make frequent inquiry and be careful to see that no employee enters upon his work at or in the mine under the influence of liquor, and shall prohibit the use of liquor by employees during working hours. Mine owners and officials shall use their utmost endeavors to restrict the sale of liquor by saloons, peddlers or others accessible to their employees, to hours between 8 a.m. and 10 p.m.

7. Hospital Facilities: At all mines there shall be on the surface a suitable place for receiving, dressing and temporarily caring for an injured person, and a surgeon shall be available within thirty minutes; a doctor's office may answer this requirement.

For all mines employing over 150 men there shall be suitable emergency hospital facilities distant not over thirty minutes from the entrance to the mine, with a surgeon and a trained nurse or first-aid man immediately available to the call of the mining company.

8. Illumination: (*a*) The illumination furnished by miners' lights shall be sufficient to enable the miner to see dangerous places and conditions. It shall not be considered that this requirement is met if

candles are used. It can be best fulfilled by the use of carbide lamps or electric cap lamps.

(*b*) Electric lights should be provided underground at shaft stations, skip pockets, magazines, pump stations, escapeways and other places where needed.

9. Checking System: In all mines there shall be an adequate system of checking in and out which shall tally each man underground. Where the men enter or leave by another entrance than that at which the checking system is maintained, there may be an additional checkboard erected and a foreman, pumpman or other employee authorized by the foreman shall examine such board and telephone to office the indication of such board. Where mine lamps are issued to all the men, the lamp check shall be sufficient.

Should the checking system indicate that any man has failed to check out of the mine within a reasonable time after the end of the shift, the operator shall cause an immediate search to be made for him.

10. Escapeways or Exits: Sections 23–27 of the Mine Safety Rules shall apply.

11. Runarounds: There shall be a separate runaround or passageway for men at shaft stations and skip pockets. This runaround shall not be less than 5 feet high and 2½ feet wide and shall be kept at all times in a safe condition for traveling. Under no circumstances should skip tenders be permitted to jump across a compartment of the shaft at any time, and railings should be so installed at skip pockets that it will be practically impossible for skip tenders to take such risks. Electric lights should be installed at all skip pockets and other dangerous places.

III. Falls of Rock or Ore.

A. *Shaft Stations.*

1. Depending upon the nature of the rock, untimbered shaft stations should not be so large as to make falls probable.

2. Danger of falls should not exist.

3. Stations should be adequately timbered.

4. Inspection of shaft stations should be made twice weekly by the foreman or shift boss.

B. *Drifts and Crosscuts (including working faces of same).*

1. Small rock should be carefully trimmed down.

2. Slabs or masses of rock should either be supported by timber or pulled down as may be necessitated.

3. Should be adequately and securely timbered where the size of the place and the nature of the ground warrants.

4. Should be inspected twice weekly by foreman or shift boss.

C. *Stopes and Other Working Places.*

1. The back or roof should be kept clear of small pieces of loose rock.

2. The back or roof should be kept clear of slabs or masses of rock, or such slabs or masses should be securely held in place by timber.

3. The method of timbering, and size of timbers, should be such as to render the working place safe. Timbers should be carried sufficiently close to the working face.

4. If the use of filling is necessitated, it should be carried sufficiently close to the roof or back to prevent the movement of walls.

5. Inspection should be made at least twice daily by the shift boss and at frequent intervals by the men working in the place.

IV. Explosives.

B. *Surface Magazines.*

1–2. Surface magazines should not be nearer than 150 feet to any mine entrance and should comply with the "American Table of Distances."

QUANTITY AND DISTANCE TABLE.

Column 1. Quantity that may be lawfully kept or stored from nearest building, highway or railroad				Column 2.	Column 3.	Column 4.
Blasting caps		Other explosives		Distance from nearest building, feet	Distance from nearest railroad, feet	Distance from nearest highway, feet
Number over	Number not over	Pounds over	Pounds not over			
1,000	5,000	----------	----------	80	20	10
5,000	10,000	----------	----------	60	40	20
10,000	20,000	----------	----------	120	70	35
20,000	25,000	----------	50	145	90	45
25,000	50,000	50	100	240	140	70
50,000	100,000	100	200	380	220	110
100,000	150,000	200	300	520	310	150
150,000	200,000	300	400	640	380	190
200,000	250,000	400	500	720	430	220
250,000	300,000	500	600	800	480	240
300,000	350,000	600	700	860	520	260
350,000	400,000	700	800	920	550	280
400,000	450,000	800	900	980	590	300
450,000	500,000	900	1,000	1,020	610	310
500,000	750,000	1,000	1,500	1,060	640	320
750,000	1,000,000	1,500	2,000	1,200	720	360
1,000,000	1,500,000	2,000	3,000	1,300	780	390
1,500,000	2,000,000	3,000	4,000	1,420	850	420
2,000,000	2,500,000	4,000	5,000	1,500	900	450
		5,000	6,000	1,560	940	470
		6,000	7,000	1,610	970	490
		7,000	8,000	1,660	1,000	500
		8,000	9,000	1,700	1,020	510
		9,000	10,000	1,740	1,040	520
		10,000	20,000	1,780	1,070	530
		20,000	30,000	2,110	1,270	630
		30,000	40,000	2,410	1,450	720
		40,000	50,000	2,680	1,610	800
		50,000	60,000	2,920	1,750	880
		60,000	70,000	3,130	1,880	940
		70,000	80,000	3,310	1,990	1,000
		80,000	90,000	3,460	2,080	1,040
		90,000	100,000	3,580	2,150	1,080
		100,000	200,000	3,800	2,280	1,140
		200,000	300,000	4,310	2,590	1,300

Whenever the building, railroad or highway to be protected is effectually screened from the magazine, where explosives are had, kept or stored, either by natural features of the ground or by an efficient artificial barricade of such height that any straight line drawn from the top or any side wall of the magazine to any part of the building to be protected, will pass through such intervening natural or efficient artificial barricade, and any straight line drawn from the top of any side wall of the magazine to any point twelve feet above the center of the railroad or highway to be protected will pass through such intervening natural or efficient artificial barricade, the applicable distances given in columns two, three and four of the quantity and distance table may be reduced one-half.

If at any time the distances from a magazine to a building, highway or railroad be decreased through the construction of a new building, highway or railroad or by any other means, then the amounts of explosives which may be lawfully had, kept or stored in said magazine must be reduced to correspond with the quantity and distance table.

The term "building" when used in the foregoing table shall be held to mean and include only any building regularly occupied in whole or in part as a habitation for human beings, and any store, church, schoolhouse, railway station or other public place of assembly.

The term "highway" when used in the foregoing table shall be held to mean public streets or public roads, and shall not include roads constructed and maintained by private persons.

The term "railroad" when used in the foregoing table shall be held to mean and include any steam, electric or other railroad that carries passengers or articles of commerce for hire.

The term "efficient artificial barricade" when used in the foregoing table shall be held to mean an artificial mound or properly revetted wall of earth of a thickness of not less than three feet.

3. Magazines should be so arranged that rough handling of explosives will not be necessary and so that the boxes of dynamite will be securely piled without crowding.

4. Magazines should be constructed of fireproof material with a bullet-proof door. There should be suitable vents for ventilation.

5. Magazines should be in protected places, rather than on or near a hilltop. All brush and other inflammable material should be cleared away from sides.

6. Dynamite and black powder should not be stored in the same magazine. No other material of any kind should be stored in a magazine with dynamite or black powder.

7. No other explosive should be stored in a detonator (cap) magazine.

C. *Transfer of Explosives to Mine.*

1. Only sufficient powder for one day's supply underground should be transferred from the surface magazine, unless all special requirements of Industrial Accident Commission are met.

2. Explosives should not be loaded on to trucks, skips or cages with men, supplies or machinery, except such men as are required to handle explosives.

3. Explosives should not be delivered to underground magazines unless intended for immediate use at the working face.

D. *Underground Storage of Explosives.*

1. There should be an underground magazine for each working level. Underground magazines should consist of a separate drive or chamber, the walls of which shall be of fireproof material or of wood covered with sheet iron. Small amounts of powder (100 pounds) may be kept in stout, tight boxes, with hinged lids and locks.

2. Underground magazines should not be closer than 75 feet to a shaft or pump station, nor should they be on a main traveled way.

3. The position of the magazine should not be such that, in case of an explosion therein, it would be impossible for men to reach the shaft station; nor should it be in such a position that an explosion would cause gases to pass into workings wherein men are employed.

4. Caps and fuses should be stored at least 50 feet away from the powder magazine.

5. Paper, pieces of powder boxes, and other rubbish should be removed from the magazine at frequent intervals.

6. Powder magazines should not be directly connected with dry timbering. There should be a space of at least 10 feet between the magazine and the last inflammable timber set.

7. Magazines should be kept locked at all times, except when explosives are being taken out. Key or keys should be in the possession only of the man or men who deliver the powder to miners.

E. *Transporting of Explosives to Working Places.*

1. Explosives should be delivered to miners at their working places by a man or men especially designated for this duty.

2. Caps and fuses should not be carried in the same receptacle with dynamite or black powder, unless made into primes with same.

F. *Thawing.*

1. Where thawing is necessary it should be carried out under supervision of someone experienced in this work.

2. Dynamite should not be thawed within the magazine or on a heated stove, steam pipes, heated rocks, bricks or metal nor in an oven. *Thawing should not* be done in front or near a steam boiler or fire of

any kind, or on the person. No thawing device employing steam under pressure should be used and no thawing device should be placed over a stove.

G. *Loading and Shooting.*

1. Only an approved crimper should be used in crimping caps. No method of making the primer that bends the fuse more than 35 degrees should be used. The primer should be made by a special man, using one of the two following methods:

(*a*) Insert the capped fuse in the top of the dynamite cartridge and securely tie the paper of the cartridge around the fuse.

(*b*) Insert the capped fuse in a diagonal hole in the side of the dynamite cartridge, securely tying the fuse to the cartridge above the hole.

2. For waterproofing use only Celakap (or some other compound sold by powder manufacturers) or roofing paint; where holes are not very wet, tallow or soap may be used—no grease of any kind should be used.

3. Drill holes should be thoroughly cleaned by means of a spoon or, if the hole is not dry, by means of compressed air.

4. Drill holes should be loaded only by men experienced in this work; the primer should be placed near the top of the hole; a wooden bar should be used for tamping.

5. There should be regular hours for blasting, preferably not more than twice per shift.

6. Where blasting is done while men are in the mine all entrances to the place where the shooting is to be done should be guarded and the usual cry of "fire" should be given.

7. In drifts and crosscuts not more than ten (10) holes should be "spit" by one man; in shafts and raises not more than eight (8) holes should be "spit" by one man.

8. In raises and shafts the battery system of firing is preferred.

H. *Misfires.*

1. Misfires should be reported by the miner to his shift boss. The shift boss, in turn, should make a written report either on a blank provided for the purpose or on a blackboard so that such report will be received by the shift boss of the next on-coming shift.

2. Misfires should be sought for and handled only by experienced powder men. An attempt should be made to blast the hole by using another primer. If this fails a new hole should be drilled not nearer than two feet from the old hole.

V. Haulage Underground.

This class relates to danger to men working or traveling on haulage ways or in working places, but not to men being transported in cars or skips.

A. *Haulage System.*

The haulage system as a whole, including motive power, rolling stock, haulage way, track system and roadbed should be kept in safe operating condition.

B. *Locomotives.*

The use of gasoline locomotives is prohibited, except by special permission of the Industrial Accident Commission. There should be a sufficient number of locomotives, under any circumstances, to safely handle the tonnage. If rope haulage is used pulleys and the tension gauge rollers should be kept in good condition. Depending upon the system used, the capacity of a car should not be too great, nor should too many cars be hauled on a trip. The body and running gear of cars should be kept in good condition.

C. *Brakes on Cars.*

Cars should be provided with sufficient brakes so that the hazard offered by the grade of the tracks will be reasonably overcome. Grades should not be so steep that they offer danger from derailment of cars.

D. *Clearance.*

Between top of car and back three feet, between sides of car and timber or rock size of haulage way one and one-half feet, between top of car and trolley three feet.

E. *Illumination.*

Where electrical haulage is used shaft stations must be electrically lighted and haulage ways must have electric light bulbs at least every 200 feet. For animal tramming a light must be carried on the first car of the trip or by the driver. For hand tramming a light must be carried by the trammer or on front of car.

F. *Condition of Track.*

Rails shall be of such weight as to safely carry the maximum load that may be imposed at maximum speed. They shall be firmly spiked, have suitable joint fastenings, and rest on a sufficient number of ties of adequate dimensions. Frogs and switches should be properly blocked on motor haulage roads. The track shall be properly aligned and free of high joints, broken rails, defective switches and frogs.

G. *Condition of Roadbed.*

Roadbed shall be kept in good condition, free of rocks, timbers, material or other obstructions, well drained and properly surfaced.

H. *Clearance of Chutes.*

Chute lips should not be projected more than three inches over the nearest side of cars.

I. *Jumping Moving Cars*

Jumping moving cars and uncoupling cars moving at speed exceeding four (4) miles per hour should be prohibited. Cars without brakes shall not be ridden on grades.

J. *Shelter Holes.*

Where mechanical haulage is used refuge or shelter places, affording space of at least two and one-half feet at side between the widest portion of the cars or train, shall be provided. These places must be kept open and clear at all times.

VI. Falls of Persons Down Chutes, Raises, Winzes, Etc.

1. Chutes and Bins: Openings to chutes or bins should be protected by heavy chains, iron bars, gratings or railings not more than six (6) inches apart. In cases where cars dump from the edge of the opening substitutes for the chains or bars may be used in the form of railings of wood or metal.

2. Raises and Winzes: Wet raises or winzes inclining more than 20 degrees from the horizontal must have stairways or ladderways in good repair. Dry raises or winzes inclining more than 30 degrees must have stairways or ladderways in good repair. Collars of winzes, raises or manways must be protected by means of doors, railings or bars.

3. All open places must be securely railed off so as to prevent anyone walking into them.

VII. Electricity.

A. Character of electrical installation---------- 20

1. Efficient guard rails and screens, insulating mats, etc., should be installed as provided by Mine Safety Rules and Electrical Utilization Safety Orders and at all other points where such installation will safeguard life; all electrical equipment should be so constructed, installed and maintained as to comply with all requirements of the Electrical Utilization Safety Orders and the Mine Safety Rules, and to reduce the accident hazard as far as is reasonably possible. All work on electrical equipment should be performed by properly qualified persons---------- 10

2. Lightning arresters should be installed and maintained in good condition as provided in Electrical Utilization Safety Orders 718–722 and Mine Safety Rules, Section 65 (4)---------- 2

3. Efficient equipment for fighting electrical fires should be kept in all underground electrical stations as provided in Mine Safety

Rules, Section 63 (6) and in all surface stations. Fire drills should be held once each month and the men in charge of or working near electrical equipment should be instructed in the use of fire fighting devices 5

4. All equipment should be so installed as to be readily and safely accessible to authorized persons, particular attention being given to compliance with provisions of Electrical Utilization Safety Orders 704, 705, 733, 741–744, 746, 760 3

B. Trolley wire 15

1. Voltage should be less than 300 5

2–3. Trolley wires should be installed at least seven feet above rail and six inches outside of track and guarded as provided for in Mine Safety Rules, Section 65 (11); additional guards being installed where they will reduce danger of accident 5

4. On straight runs the hangers should be placed not more than 20 feet apart. On curves the hangers should be placed so close together that the trolley wire at any one hanger may be entirely disconnected without exposing the motorman to danger of contact. In no case should the sag of the wire between supports exceed three inches. All hangers should be securely fastened in a workmanlike manner 2

5. Underground trolley lines should be sectionalized every 1,000 feet by placing in the line a switch by which the line can be entirely disconnected from the power supply. All branch trolley lines should be provided with a frog at the point where they leave the main line and also with a switch installed at or near the frog, by which the branch can be disconnected from the main. Trolley wires that are less than seven feet above the top of the rail should be protected at all points where men are regularly required to work or pass under them and at all points where men may come in contact with the wires. The tracks of all main haulage systems that use a rail return should be bonded at every rail joint, and cross bonding should be placed at intervals not exceeding 200 feet. Special provision should be made for bonding around all switches, frogs, or openings in the track, so as to insure a continuous return. Drawbars and axles of cars used in electric trains should be bonded 3

C. Stationary motors; pumps, hoists, fans, etc. 15

1. Effective illumination should be provided in the vicinity of all moving machinery in or about the mine, and should be so installed that moving parts are well illuminated. Emergency lights should be provided as required by Mine Safety Rules, Section 63 (7) 2

2–4. Exposed live controller contacts, unprotected motor terminals and unprotected switches should be cared for as provided in Electrical Utilization Orders 733–740, 747–751 13

D. Transmission lines and cables, including illuminating circuits, underground transformers, etc. 40

1. No exposed wires of 300 or more volts should be permitted underground. Where conductors carry more than 300 volts, either on surface or underground, all requirements of Electrical Utilization Safety Orders (723–731) and Mine Safety Rules should be complied with 5

2. Cutouts and circuit breaking devices should comply with Sections 66, 67 (*a*) of Mine Safety Rules and with Electrical Utilization Orders 733–740 5

3. Switch parts must be properly aligned and so installed as to make *operation* safe and easy 2

4. Circuit breakers should be set so as to adequately protect the equipment against overheating due to excessive current and in no case should a greater overload than 50 per cent be permitted. Overloads of 50 per cent should not be sustained for more than ten seconds ---------- 5
NOTE.—This may necessitate installation of time element relays.
5. Cases of all motors, transformers, oil switches, starting boxes, rheostats, and compensators must be effectively grounded------ 5
6. Illuminating circuits should be kept in first class condition and all burnt out globes should be promptly replaced---------- 5
7. When insulation is worn deeper than the outer braid the conductors should be replaced---------- 3
8. Sections of cable armor, if broken or sufficiently deformed to impair the value of insulation underneath, should be replaced-- 3
9–10. Where sag is caused by stretching the conductor, the conductor should be replaced, and where produced by loosening of supports, the supports should be substantially fastened---------- 5
11. All joints of conductors should be made mechanically close and should be thoroughly soldered---------- 2

E. Miscellaneous ---------- 10
All reasonable safety precautions should be observed and necessary safety requirements to fit special conditions existing at individual operations, should receive careful attention.

VIII. Miscellaneous.

This group includes those dangers to underground workers not included in other groups.

A. *Transporting and Handling.*

Care shall be exercised in transporting timbers, ties, rails, slate, rock, etc., in the mine, and in handling, setting or placing same. No material shall be transported on top of haulage motors, but same should be carried only in cars or trucks adapted to the material to be hauled.

B. *Chutes and Pockets.*

Approved types of doors must be used on all chutes leading from bins or pockets from which ore or rock is drawn.

C. *Drilling*

Drilling should be practiced so as to present a minimum hazard in setting up and running drilling machines.

D. *Machinery and Miscellaneous Tools.*

Care must be used in handling and installing all machinery.

E. *Mine Fires.*

There shall be adequate fire protection at the collar of all shafts. Such equipment should include fire hydrants and hose, or fire extinguishers, or both. At all dry shaft stations there should be a hydrant and hose with a dependable water supply, or a barrel of water with buckets nearby. If fire extinguishers are used men should be instructed

in the use of same. In dry timbered crosscuts, drifts and working places, water must be available from some source; either from water barrels, from a special water line or from the air line.

F. *Gases.*

If natural noxious gases exist in the mine precaution should be observed to prevent its injuring the men, either by means of proper ventilation or ready means of escape. Men should not be allowed to return to "dead ends" after blasting until powder gases have been blown out or otherwise removed.

G. *Inrush of Water.*

A barrier of at least 50 feet shall be maintained between the working face and any abandoned mine containing a dangerous accumulation of water, until same has been drained off. When approaching abandoned workings, advance bore holes shall be driven. When working under ditch, river, lake or other body of water, special precautions shall be taken to prevent flood. The opening to every mine shall be protected from any possible inrush of water due to cloudburst or flood.

H. *Other Causes.*

This includes any dangerous conditions existing in the mine not covered by other orders set forth herein.

IX. Shaft Hazards.

A. *Headframe.*

The material and construction of the headframe and machinery or other device used for supporting the cage or skip shall be so strong and durable as to assure its withstanding any strain put upon it. It should be so designed that it will withstand a greater load than the calculated breaking strain of the hoisting attachments. Where headframe is constructed of inflammable material there shall be furnished adequate fire protection. The headframe should be so constructed as to secure the maximum protection for men working on or around it.

B. *Hoisting Engine.*

This shall be of such kind and in such condition as to assure certainty of operation and ease of control. There shall be hand or other brakes adequate to stop the cage in ten (10) feet under all conditions of operation. There shall be drum guides or horn of sufficient height to restrain the rope from slipping off the drum; the cable fastenings shall be absolutely secure against the maximum emergency strain. The hoisting engineer shall be a person skilled in or licensed for such duties.

Hoisting engines shall be so placed that the noise of air compressor or other machinery will not prevent hearing the signals, and that the

attention of the engineer will not be detracted. Notices shall be posted forbidding loitering around or conversation with the engineer when operating the engines. The employees in charge of the boiler and engine shall be skilled in their duties. The point of control for hoisting engines shall be in close proximity to the engines, except where electrical control is used, in which case it shall be in accordance with approved standards. Where there is an engine and cage at escape shaft, steam shall be kept at the throttle at all times, and the cage shall be run the entire length of the shaft at least once daily. Adequate facilities shall be provided for keeping the engine drained.

C. *Cable.*

The hoisting rope or cable should have an ultimate breaking strength of ten times the maximum load, but in any case shall have such ultimate strength of seven times the maximum load it will ever be called upon to carry. There shall be a thorough inspection of the rope, its attachments, the cage, sheave and hoisting engine once a week, and a record shall be kept of this inspection. The rope shall make at least two full laps on the drum and shall be securely fastened to the drum in accordance with approved methods. The rope should be kept well greased with a proper grease and should be discarded as soon as inspection reveals any defects in it. The rope shall be fastened to its load either by means of a socket, or by a clamp and thimble, either style of fastening to be made in an approved manner.

With either style of fastening the rope should be resocketed or reclamped at intervals not to exceed three months of actual use, at which time all fractured or worn parts of the rope shall be cut off.

D. *Gates, Bars, Etc.*

There should be suitable gates or bars at shaft collars and shaft stations. If only bars are used they should stand at least one and one-half feet from the edge of the shaft. The installation of chains shall not be considered to meet this requirement.

E. *Hoisting and Lowering Men.*

1. Safety catches must be used on cages in vertical shafts; they should be inspected daily and tested once each month.

2. Vertical shaft skips for handling men must be equipped with safety catches, which shall be inspected daily and tested once each month. Where the shaft is more than 300 feet deep the skip should be provided with an iron bonnet. In either vertical or inclined shafts, skips or cages must not be overloaded and only two men should be allowed to ride the bail. Boards shall not be placed across the top of skips and men permitted to ride thereon, unless side casing is provided as a protection. Guides or back-runners should be installed in all

hoisting shafts when the inclination is more than 20 degrees from the horizontal, and safety catches should be used on man cages or skips. When hoisting or lowering men at the beginning or end of each shift, special man cages or skips should be used in all shafts where the angle of inclination from the horizontal exceeds 20 degrees and when the angle of inclination exceeds 30 degrees, such cages or skips should be equipped with bonnets to protect men from falling rock. In general, depending on the nature of the hoisting equipments, unsafe practices must be eliminated.

3. Guides and Tracks: The guides of vertical shafts and the tracks and "back-runners" of inclined shafts should be inspected daily.

4. Moving Ground: Where inspection shows that guides or tracks have been shifted by moving ground, repairs must be made immediately.

5. Wall plates must be kept clear of accumulation of broken rock.

6. Crowding: Men should not be allowed to crowd around the shaft collar or the station, previous to lowering or hoisting. If conditions permit, chains should be provided at shaft stations so that only a cage or skip load of men can approach the shaft at one time.

F. *Shaft Ladderway.*

The provisions of section 40 of the Mine Safety Rules shall be fully complied with. In addition, main ladderways with an inclination of more than 50 degrees from the horizontal, the distance between the top and bottom of which is more than 50 feet, should have substantial platforms at intervals of not more than 20 feet measured along the inclination; and the sections of the ladders should be staggered at each platform so that no section is directly in line with the section above or below.

In main escapeways, ladders should be provided when the inclination is more than 40 degrees from the horizontal.

G. *Skip Pockets.*

At all skip pockets electric lights should be so placed that efficient illumination is given in addition to the light from the skip tender's lamp. Ample runways should be provided and securely railed off from the shaft so as to make it unnecessary and inconvenient for the skip tender to cross the shaft.

H. *Hoisting Signals.*

Adequate hoisting signals and signal devices must be installed. Where the shaft is more than 500 feet deep, electrical signaling devices should be used. At all shaft stations and skip pockets the means of signaling must be conveniently located and must work easily so that a man, while standing on the cage or skip, can signal the engineer without difficulty. Telephones must be installed at all working levels at and deeper than 500 feet, and must be kept in good working order.

X. Surface Hazards.

This class relates to all kinds of dangers to men working or traveling on the surface.

A. *Power Plant.*

There shall be a semiannual inspection of all boilers, portable, locomotive and stationary, and of all compressed air tanks, by an insurance company, an approved state or county boiler inspection department, or by a competent boiler maker. The records of these inspections shall be so kept that they will be available for inspection. Each boiler shall be equipped with an efficient water gauge column, properly placed and kept clean for easy observation of water level. Each water gauge column glass shall be provided with an approved guard which will protect against flying pieces of glass, and so arranged as not to obstruct clear observation of water level. Each blow-off valve or pipe within seven feet of the floor or platform shall have its outlet so located or protected that anyone passing may not be scalded. There shall be two safe means of exit from all parts of the boiler room. Runways and stairways should be provided so that there may be easy access to top of boiler. Adequate protection and warning signs should be furnished for men working inside the boilers or on steam lines. Boilers should be in detached boiler houses at least 60 feet from the engine room and other inflammable buildings, or should be enclosed by fireproof wall. Boilers should not be located closer than 100 feet from any mine opening, unless there is an additional opening at head of work and at least 200 feet from the opening affected by such boiler house.

In addition to the usual automatic blow-off valve air compressor systems shall be equipped with a fusible plug or plugs (located in discharge line as close to compressor as practicable), which will open at temperatures in excess of the flash point of the lubricating oil in use (450° to 500° F. is flash point of ordinary cylinder oil and 550° to 650° F., of high test lubricating oil).

Engines shall have fly wheel and all other moving parts suitably and adequately guarded. Fly wheels over four feet in diameter should be inspected periodically. Each engine should be provided with an effective governor to control its speed under varying loads.

Electrical apparatus, such as generators, motors, switchboards, transformer and controlling and operating apparatus, shall have all moving parts guarded. They shall also be so protected as to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

All steam lines should be adequately supported and protected from falling objects. All exhaust steam shall be so conducted away that it will present no hazard to workmen.

B. *Machinery.*

All moving parts of machinery about the surface plant, such as gears and pinion wheels, sprockets, chains, bandsaws, belts, pulleys, clutches, wheels, shafts, the arbor ends of shafts, spindles, couplings, counterweights, revolving and reciprocating parts, circular and rip saws, emery wheels, and all other dangerous points, parts or projections, shall be guarded in accordance with approved standards. Wherever possible, machinery should be oiled while it is at rest; adequate runways and stairways shall be provided for use of oiler in oiling line shafts, and the like. In machine shops, adequate clearance shall be provided around all machines and shall be clearly indicated.

C. *Cleanliness.*

Roads and paths in yards and walks in buildings, and other places where men must work or travel, shall be free from loose or fallen materials or other obstructions over which men may stumble. All material shall be stored or piled in a workmanlike manner.

D. *Chutes and Bins.*

These should be ventilated, guarded and posted with suitable warning signs. When men work in chutes or bins, warning notices shall be posted and other persons concerned notified. No open lights or fires shall be allowed in the vicinity of chutes or bins, and while cleaning same, electric lamps used for illumination shall be protected by wire cages.

E. *Electricity.*

The maximum voltage for exposed bare wires shall be 300 volts, and for exposed properly insulated wires 500 volts.

Trolley wires and other exposed wires on the surface under which men work or travel shall not be less than seven feet above the rail. At points where men regularly pass under bare wires, the wires should be protected by guards if less than eight feet above rail. All exposed bare wires shall be suitably guarded and warning signs posted at all electrical hazards.

F. *Illumination of Buildings.*

All reasonable efforts shall be made to provide adequate illumination in all places where men must work or travel.

G. *Surface Haulage.*

On all surface haulage there shall be adequate clearance provided. There shall, wherever practicable, be two distinct methods of protection against hazard of grade or incline; by positive stopblocks at top of landing and a positive action derail near the top and one at bottom, if

it appears necessary and practical. All railway frogs and switches shall be blocked, and track shall be kept in good condition. Where rope haulage is used the rope shall not be disconnected while the trip is moving faster than four miles per hour and the rope shall be handled with a hook or other equally safe device.

All jumping of moving trips at speeds exceeding four miles per hour should be prohibited. When necessary, a suitable signaling device should be installed. Men should not ride trips on surface planes or slopes unless there is an adequate safety device to prevent breaking of trips.

H. *Refuge Places.*

At the bottom of each grade or incline on which cars are hoisted or lowered there must be provided means for the escape of anyone who might find it necessary to step aside in order to avoid injury from a runaway car or cars.

I. *Railways.*

Adequate warning signs must be displayed at all crossings. At least 20 inches clearance shall be provided alongside of railroad tracks and this space shall be kept clear from all material. Condition of track and roadbed should be such as to assure that cars shall not jump rails at any possible speed; frogs and switches shall be blocked and on grades the cars should be kept under control by a brake, a suitable car retarder or other mechanical device.

J. *Floors and Stairways.*

Openings in floors shall be protected by guardrails conforming to approved standards, or be covered by a hinged trap door of substantial construction, capable of being blocked open when necessary and guarded or kept closed when the opening is not in use. Stairways should not be set at an angle of more than 45 degrees. They shall at all times be kept in good condition. All of the treads in any one flight should be of the same width, and all of the risers should be of the same height. Adequate handrails, toe boards and illumination shall be provided for all stairways. The standard shall be stairways. If ladders are used they shall be credited as half standard if they comply with the following: Ladders shall have nonslip shoes, or if over 15 feet in length or over 60 degrees pitch shall be securely fastened. The rungs shall be securely fastened, equally spaced, and not over 15 inches apart. Ladders over 75 degrees pitch and over 50 feet in height shall be caged in.

K. *Fire Protection.*

Where there appears to be the possibility of the loss of life from fire, there shall be sufficient fire protection on the surface, including water supply, fire plugs, and accessible hose, nozzles, chemical or automatic extinguishers, properly located, to provide for the safety of workmen, and adequate fire exits shall be provided in all tall buildings or large mills. No open lights shall be taken into any ore crusher room, chute or bin. No wood or oil shall be allowed within one foot of any steam pipe.

L. *Falling Objects.*

Timber and store room supplies shall be safely handled and stored. Materials and tools of all kinds shall be kept in their proper places. Adequate screens or bumpers shall be placed at all points where large rocks are likely to fall.

M. *Miscellaneous.*

Openings or dangerous places in the ground surface shall be fenced and plank runways in buildings shall be protected. All public or private railway or other surface haulage crossings over which employees must pass to and from work shall have suitable danger signs posted; all necessary short cuts or exposure to passing trains should be fenced; picking of ore under railway tracks should be prohibited. Teaming and construction work shall be safely conducted.

Application.

After the merit rating system is applied to an individual mine, and it has been decided by the inspector what demerits shall be given under each heading, the rate can then be computed as follows: The sum of the demerits under each heading is multiplied by the relative weight of that heading and the resulting products are added together, after which the rate is computed by applying the standard formula shown in the computations which follow. After careful inspection in the field a trial merit rating was recently made at a mine where conditions are better than the average. This will serve to illustrate the method of computing the insurance rate after deciding upon the demerits.

I. Safety organization, inspection service and education ---------- 25 %
Demerits—32 out of a possible 100.

II. Safety measures ---------- 15 %
Demerits—36 out of a possible 100.

III. Falls of rock or ore ---------- 15.1%
Demerits—20 out of a possible 100.

IV. Explosives ---------- 10.6%
Demerits—38.5 out of a possible 100.

V. Haulage underground ---------- 1.7%
Demerits—37 out of a possible 100.

VI. Falls of persons down chutes, raises, winzes, etc. ---- 4.5%
Demerits—40 out of a possible 100.

VII. Electricity ---- .7%
Demerits—0 out of a possible 100.

VIII. Miscellaneous underground hazards ---- 10.4%
Demerits—47 out of a possible 100.

IX. Shaft hazards ---- 9.8%
Demerits—50 out of a possible 100.

X. Surface hazards ---- 7.2%
Demerits—32.5 out of a possible 100.

I. 32 × 25 % = 8
II. 36 × 15 % = 5.40
III. 20 × 15.1% = 3.02
IV. 38.5 × 10.6% = 4.081
V. 37 × 1.7% = 0.627
VI. 40 × 4.5% = 1.8
VII.
VIII. 47 × 10.4% = 4.888
IX. 50 × 9.8% = 4.9
X. 32.5 × 7.2% = 2.34

Total ---- 35.056

The final merit rate is figured by using the following formula:

$$M = B\ (1.00 - u) + x\left(\frac{u\ B}{L}\right)$$

M = Merit rate
B = Base rate ($5.75)
u = Max. reduction in per cent (40)
L = Charges for standard or average mine
x = Charges for specific mine

If assume 50 for L and 35.06 for x we have

$$M = .60 \times 5.75 + 35.06\left(\frac{.40 \times 5.75}{50}\right)$$

$$= 3.45 + 1.61 = \$5.06$$

According to this rating, $5.06 per $100 of pay roll would be the merit rate for the mine in question.

Additional trial merit ratings of various mines in the State are being made in this office from notes taken by mine inspectors. These will be used merely to assure ourselves that the schedule is practical. None of the trial ratings need be given serious consideration when the final inspections and ratings are made.

The reader should bear in mind that merit rating will not result in the rates of all mines being decreased to a point below the base rate (which is now $5.75 per $100 of pay roll). The merit rating must be so conducted that the total amount in premiums to be paid by mining companies will be approximately the same as it would be without merit rating; but companies operating under relatively dangerous conditions will pay a larger proportion of this amount. The maximum reduction in premium which can be secured at any mine is 40 per cent. Hence,

with the present base rate of $5.75, the lowest rate that could be obtained would be $3.45 per $100 of pay roll, but it is very doubtful if, at the outset, there will be a mine in the State that can secure so great a reduction. On the other hand, it is doubtful if there are any mines in the State that would have to pay the maximum rate of $8.05 (per $100 of pay roll), plus increases required by reason of the fact that they are located more than three miles from medical aid. (See table on page 12, which shows increases due to distances from medical aid). The maximum rate of $8.05 is computed by assuming that the demerits for the average mine would be 50 under each main division and that the base rate will remain $5.75 per $100 of pay roll. Trial ratings will show what number of demerits must be given the average mine in order that the total amount paid in premiums will remain the same after merit rating becomes effective. It may be found necessary to have the quantity "L" (charges for the standard or average mine) either more or less than 50. As will readily be seen by reference to the formula, changes in this factor will have a marked effect on the final merit rate of any mine. For instance, if the charges for the average mine are assumed to be 30, the maximum rate for the most dangerous mine would be $11.12 (per $100 of pay roll), plus any increases required by distance from medical aid. If the charges for the average mine are assumed to be 60, the maximum rate for the most dangerous mine would be $7.28 (per $100 of pay roll), plus any increases required by distance from medical aid.

It is requested that those interested in the merit rating plan should send to the writer, before July 15, 1917, or as soon thereafter as feasible, all criticisms on the proposed schedule, in order that due consideration may be given the opinions of interested parties. It is also requested that in making criticisms it should be borne in mind that the proposed schedule is a tentative one and does not entirely satisfy those who have prepared it; in fact, parts of the schedule are evidently inadequate, but those who prepared it were unable to suggest more practical and workable substitutes for the parts in question. This bulletin is submitted in the hope that out of the constructive criticism obtained may come suggestions which will materially improve the schedule.

If you are interested in securing a merit rating system for California mines, and feel that this schedule is adequate, you can assist us materially if you will send a letter to the writer, indorsing the proposed schedule. Such cooperation should result in reducing the time which must elapse before the scheme can become effective.

BULLETIN No. 7

RELATING TO

Safeguards Against Injury in Mines

MARCH, 1918

Issued by the
Industrial Accident Commission
of the
State of California
In Cooperation with
United States Bureau of Mines

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA
In Cooperation with United States Bureau of Mines.

BULLETIN No. 7.

Relating to Safeguards Against Injury in Mines.

By F. L. LOWELL, Deputy Mine Inspector.

FOREWORD.

In view of the fact that the Workmen's Compensation Insurance and Safety Act has been in effect several years, and that the mines have been gradually adjusting their working conditions to meet the requirements of the Mine Safety Rules, it might be well at this time to describe some of the improvements that have been made for the protection of the miner while in the pursuit of his duties.

As it has been the policy of the Industrial Accident Commission to publish bulletins from time to time on methods of preventing injuries to employees, we now wish to produce a number of examples of good and improper protection which are illustrated by photographs taken in the field during inspection trips and by views furnished by the U. S. Bureau of Mines.

As a prelude to the succeeding pages of this bulletin, it might be well to submit a few statistics on the number of fatal, permanent and temporary injuries and the compensation and medical expense entailed for the year 1916.

In metal mining, as well as in gold dredging and quarrying, the greater number of injuries were caused by falling, rolling or flying objects, such as falls of rock, steel, timbers, tools, etc., while dangerous substances* take second place in point of numbers in the three lines of industry.

During 1917, the mining division received notification of 58 fatal injuries out of a larger total number of men employed than in 1916. Seven of these fatalities occurred in one mine at one time, but in spite of this we hope that the percentage of fatal injuries this year will show a marked decrease in percentage over last year.

Memorandum of Mine Accident Data for the State of California During the Year 1916.

There were 6,385 industrial injuries reported by operators of mines, quarries and dredges during the year 1916 in the State of California.

By degree of injury they are as follows:

Fatal	72
Permanent	158
Temporary	6,155
Total	6,385

*NOTE.—"Dangerous substances" mean such substances as electricity and electrical equipment, explosives, hot metals, etc., or any other similar substance which is dangerous to handle.

The chief causes of the injuries occurring in all metal mines of the state were as follows:

	Number temporary	Number permanent	Cases fatal	Days time lost in temporary cases	Award in permanent and fatals	Compensation paid, all cases	Medical paid, all cases
Machinery	207	21	4	2,361	$4,930 78	$3,513 71	$4,047 80
Dangerous substances	566	10	17	4,087	33,271 14	12,915 93	5,327 50
Falling, rolling and flying objects	2,100	52	14	19,883	41,521 71	49,571 68	24,915 10
Personal falls	461	9	9	6,403	8,576 36	13,922 59	7,450 35
Animals	29			404		378 00	296 00
Collisions and derailments	483	15	5	5,779	10,258 44	7,982 37	3,987 50
Tools	372	2	1	2,752	1,188 00	2,642 80	2,205 75
Miscellaneous	224	1		2,776	240 70	2,142 00	1,588 00
Unknown	40			404		273 00	458 00
Totals	4,482	110	50	44,799	$98,987 08	$98,642 08	$50,456 00

The chief causes of the injuries occurring in and around the gold dredges of the state were as follows:

	Number temporary	Number permanent	Cases fatal	Days time lost in temporary cases	Award in permanent and fatals	Compensation paid, all cases	Medical paid, all cases
Machinery	44	5	1	616	$3,058 89	$2,789 57	$1,366 05
Dangerous substances	62			310		178 00	697 00
Falling, rolling and flying objects	172	3		661	2,688 78	3,011 18	1,190 00
Personal falls	53	1		407	578 35	202 00	888 00
Animals	4			53		52 00	60 00
Collisions and derailments	35	1		344	206 14	450 14	674 85
Tools	44			154		12 00	262 00
Miscellaneous	29			127		196 00	315 00
Unknown	1		1				3 00
Totals	444	10	2	2,672	11,483 16	6,942 89	5,257 50

The chief causes of the injuries occurring in the quarries of the state were as follows:

	Number temporary	Number permanent	Cases fatal	Days time lost in temporary cases	Award in permanent and fatals	Compensation paid, all cases	Medical paid, all cases
Machinery	77	9		782	$7,335 60	$3,686 80	$301 00
Dangerous substances	206	5	4	1,132	9,454 10	3,672 06	1,516 10
Falling, rolling and flying objects	473	19	8	4,005	14,105 09	10,849 62	5,475 80
Personal falls	139		1	2,023	1,760 00	1,789 00	1,230 50
Animals	8			117		50 00	59 00
Collisions and derailments	151	3	3	1,770	6,184 14	2,482 46	1,795 45
Tools	84	2		744	16 60	627 41	494 00
Miscellaneous	79		4	810	1,350 00	1,666 28	1,023 00
Unknown	12			79		34 00	149 00
Totals	1,229	38	20	11,462	$40,205 53	$24,857 63	$12,512 85

CARE OF THE INJURED.

A large part of the Mine Safety Rules is devoted to the guarding of numerous dangerous working places which exist underground and on the surface, but it will be interesting at this time to note that among the first aid supplies that are required to be within easy reach at a mine, the Homestake stretcher is one that is approved and recommended for underground use, as it is especially adapted for the transportation of an injured man up or down raises and winzes. This stretcher with canvas,

Homestake stretcher for underground and surface work. (B. M. Photo.)

instead of leather straps, can be purchased for $18 or, on application to the Chief Mine Inspector, specifications for the stretcher will be sent gratis.

The Stokes Navy Stretcher, which can be purchased for $36, is also approved for mine work. It is constructed of wire mesh and fits the form of the patient and contains straps for binding the patient in place.

The Industrial Accident Commission now has a first aid instructor continually employed among the mines, gold dredges and quarries of the state. This instructor will be able to train many men, who in turn will be able to give the new men the benefit of their knowledge, thus gradually reaching all miners with this highly valuable instruction.

U. S. Bureau of Mines Car No. 1 has been assigned to California for a portion of each year and is now engaged in visiting some of the mining

camps where the instructors on the car are teaching first aid as well as the use of the self-contained oxygen mine rescue apparatus.

Stokes navy stretcher for underground and surface work.
(B. M. Photo.)

MINE RESCUE APPARATUS.

The use of self-contained oxygen mine rescue apparatus was required by the Mine Safety Rules because past records show a heavy loss of life and property due to poisonous gases from mine fires and powder fumes. The fact that California mines have been relatively free from loss of life from this cause is not a valid argument against the installation of mine rescue apparatus. Many of the deep mines of the state have considerable timber and powder underground; some also are using oil lamps for station illumination and candles for mining work. The use of candles in extensively timbered mines is not only an unnecessary risk but also a source of high mining costs. There have been fires in California mines in recent years and also cases where the mine rescue

U. S. Bureau of Mines Car No. 1, at Colfax, Placer County, Cal.

Men trained in the use of the Proto mine rescue apparatus.

apparatus would have been useful in removing miners who had been overcome by the poisonous gases from powder fumes, so I say this apparatus is as useful during and after a fire as the fire extinguishing appliances are in putting out a fire.

Conditions in many California mines are more favorable for a disastrous fire than conditions were at the North Butte mine, where 162 men lost their lives June 8, 1917. A careful study of the confidential reports of occurrences at the Butte fire indicate, beyond question, that many

Men trained in the use of the Draeger mine rescue apparatus, standing in front of their training smoke room underground.

lives were saved because mine rescue apparatus was available very soon after the fire started.

Two types of two-hour self-contained oxygen mine rescue apparatus are now being used in California mines, namely, the Fluess Proto and the Draeger. The mines of one district have established a cooperative station and employed a man to instruct the miners of the participating mines in the use of the apparatus. It is not always convenient to establish a cooperative station, however, in which case the mine is required to provide a place for the men to practice in irrespirable gases with the apparatus.

FENCING ABANDONED SHAFTS.

A law passed by the legislature of the State of California in 1903 requires that all abandoned mining shafts or other open pits dangerous to pedestrians or live stock must be either covered over or surrounded by a fence. This law is fairly well complied with, but instances have been noted where the guardrail has been allowed to deteriorate and

A poorly guarded abandoned shaft.

finally become a menace rather than a safeguard. For instance, the accompanying illustration of an abandoned shaft that formerly had a double rope guard now has only the lower rope stretched from post to post, which, being so close to the ground, might on a dark night cause a person to trip and fall headlong into the shaft.

RAILS AND MACHINERY GUARDS.

Guardrails taken together with machinery guards are life savers about a mine, gold dredge or quarry. The top rail should be 3½ feet high with an intermediate rail midway between the top rail and the platform or floor. If the platform exceeds six (6) feet above the floor level, and is above the floor so that tools could be pushed from the platform on men who are on the floor below, then a toe board at least six (6) inches high is required. The accompanying illustration will show a fence about an operating magnesite furnace at the right and

Illustration of a double rail guard about magnesite kilns and roadway above the kilns.

also about the furnace under construction at the left and the roadway above the furnaces. Guardrails can be constructed of metal or wood, but in all cases the standards must be securely fastened at the bottom.

An illustration of lack of guards over the beveled gears and sprocket wheel and chain is shown in the view of the conveyor belt. Note that the oiler is required to reach in to the grease cups in order to turn them down. It is often claimed by superintendents that the machinery is supposed to be shut down when the grease cups are turned down, but unfortunately cases where such operations have been carried on with the machinery in motion have been witnessed by the mine inspectors.

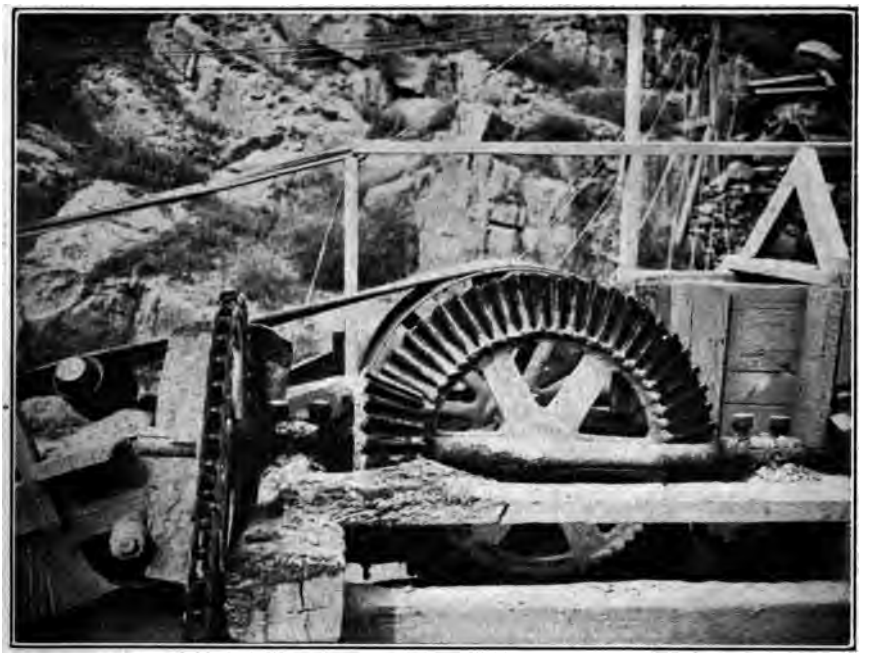
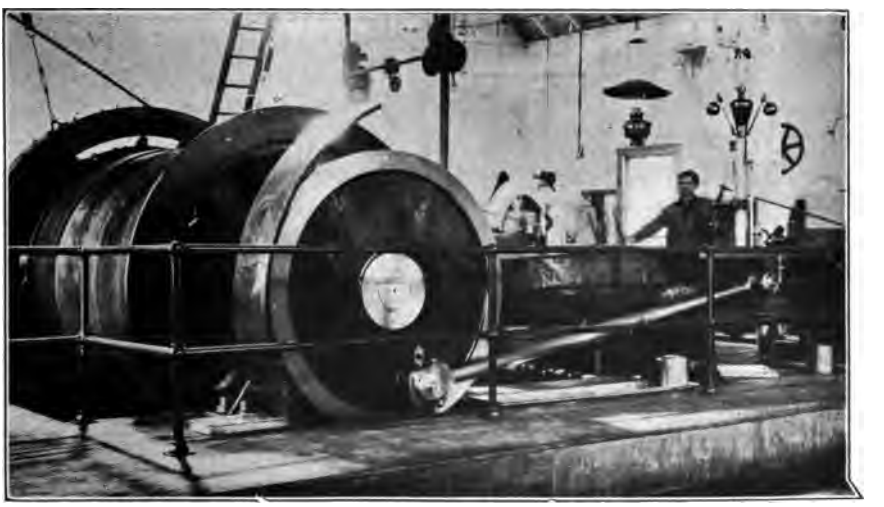
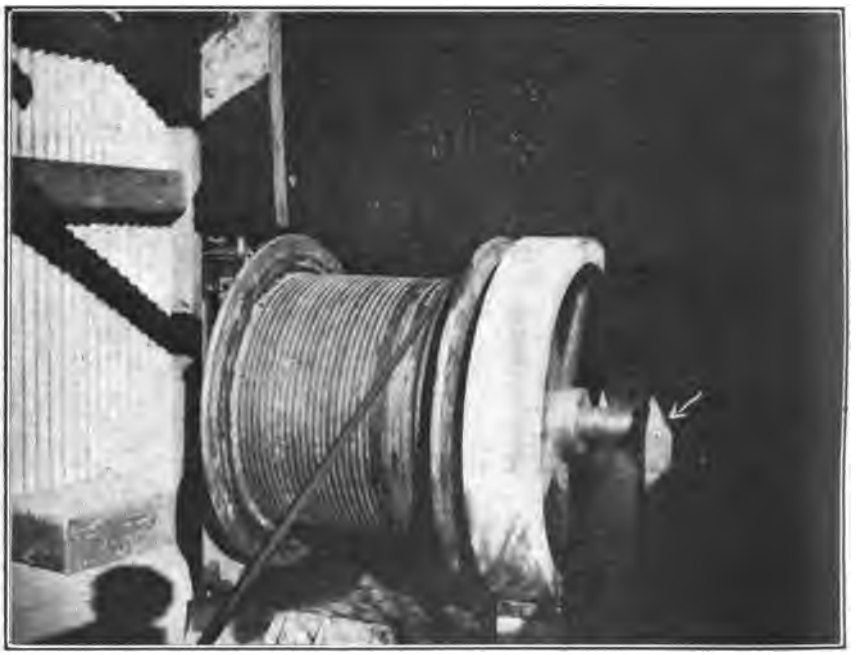


Illustration of lack of machinery guards.

In the two following views I wish to call attention to the good guard-rail of metal about the mine hoist and also the efficient metal guard over the gears of the underground electric hoist. Note that the end of the shafting for the rope drum is also protected from contact.



A well guarded mine hoist. (B. M. Photo.)



A well guarded underground hoist.

Moving ends of shafting have been the means of many men receiving fatal and permanent injuries. Men are receiving injuries by having their clothing caught by the revolving shaft, even though the shafting is without key seat. Recently a man had his left arm torn off above the elbow by a moving shaft; in his endeavor to extricate himself he pushed his arm between a heavy moving belt and pulley.

WASTE DUMP TRACKS.

Ordinarily one would not attach much risk to work on a surface ste dump. In the illustration the man who is hanging to the side the ore car sees none. He is endeavoring to dump the remaining rock m the car and is taking a big chance of the car and truck overturn- g and crushing him beneath it, as well as badly bruising him on the

Unsafe practice on a mine waste dump. (B. M. Photo.)

ll down the dump to the bottom. Note that the opposite wheels ve left the track.

A man of this description should be severely reprimanded, and if e offense is repeated he should be discharged, for there is no guard ainst a careless man of this kind.

Another very common occurrence on dumps is the failure to provide bumper at the end. I have noticed many ore cars that have gone er the dump. This may end happily if the trammer does not go ith *the car, but if he does*, the physician receives a call and the tram- *r has a few idle* and payless days—or perhaps a funeral.

SANITATION, BATH FACILITIES, DRINKING WATER.

Oftentimes advantage is not taken of the natural contour of the country in a mining district in laying out the sanitary conveniences; for instance, a large California mine, with a side hill location and plenty of natural drainage, now has a large number of dry closets, some of which it has been necessary to remove from too close proximity to

An approved sanitary mine surface toilet.

the mess hall and meat house. This mine could have a splendid sewerage system.

The illustration shows a recently completed dry closet on a California mine. Note that the openings for ventilation are screened and that the door is self-closing. This type of closet meets the necessary requirements and is being installed over the whole property.

U. S. Bureau of Mines Bulletin 139, entitled "Control of Hookworm *Infection at the* Deep Gold Mines of the Mother Lode, California," *gives one a good idea* of the extent of infection in these mines and the

ods of eradicating the evil. This information was gathered and ıiled by Dr. James G. Cumming, Director of the Bureau of Com- ıcable Diseases, California State Board of Health, and Joseph H. :e, Sanitary Engineer, U. S. Bureau of Mines.

ıe bulletin discusses the spread of the disease and methods of ɔating it, and in the text is discussed the very important subject ndergroud sanitation.

ıderground dry closets have been in use in other parts of the United ɛs for some time, but their use in California mines has been limited.

An underground mine convenience.

accompanying illustration shows a type of underground toilet now ; used in some of the Mother Lode mines. These are taken to the ıce at stated times when the miners are out of the mine.

portable convenience shown in the following illustration can be to advantage where cages are used for hoisting men, as the car can ın into the cage and hoisted to the surface.

Portable underground mine convenience. (B. M. Photo.)

A recently constructed shower bathhouse on a mine where formerly there was no bathhouse.

This car is fitted with a trapdoor in the back, which is clamped in place and made tight by the use of a gasket. Before using the car, a deodorizing fluid is paced in the bottom, and after emptying, the car is cleansed with a jet of water from a hose.

Bathing facilities on the mines are being gradually improved, as will be seen by the illustration of a bathhouse containing six shower baths recently built on a mine where formerly there was no bathhouse. It is located near the boiler house, so that plenty of hot water is available at all times.

The following illustration shows a more pretentious change house, showing the wash-sinks and showers. The floor is concrete and the

A modern mine bathhouse. (B. M. Photo.)

janitor is able to turn the hose on the equipment and thoroughly cleanse it.

An act of the state legislature which went into effect August 8, 1915, makes it compulsory for every employer of labor in this state to provide fresh and pure drinking water to his employees during working hours.

The following illustration shows a sanitary drinking fountain at a shaft station which is supplied from a reservoir on one of the upper levels. The reservoir is concreted up and protected from contamination and the water is piped down the shaft to each level, where a sanitary fountain is installed at each station. Note the mine telephone beside the drinking *fountain.*

Underground mine drinking fountain as shown by the arrow.

TIMBERING AND PILLARS.

From statistics it is learned that falling, rolling and flying objects are responsible for the greatest percentage of injuries in mines. It is therefore necessary to pay more than casual attention to the proper support of the walls and vein matter.

Some of our larger Mother Lode mines find it necessary to use square sets where the quartz is soft and filled with small fractures, through which water permeates the whole ore body. The cost of timbering alone in some of these mines has amounted to fifty cents for every ton of ore sent to the mill. Large width of the ore body, with the tremendous weight carried by the timbers, necessitates their replacement frequently. The following illustration will show lack of timber repairs in a drift where the weight of the ground has caused the sets to become distorted. The inevitable end will be a total collapse of the timbers and the drift will be closed to further travel. A drift of this kind should be entirely closed to traffic if the ground is of such a nature that it is liable to come in suddenly.

The second illustration following will show safety first in mine timbering. Note that the last set is close to the face of the drift and securely *lagged overhead.* The mine in which this view was secured is one of

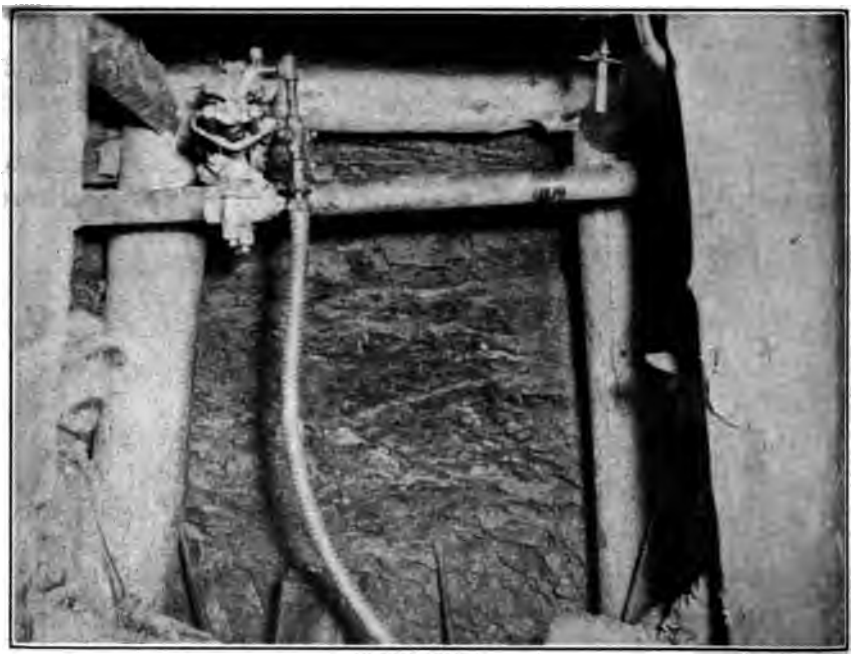
the best timbered mines in the state and it is not considered a high grade mine.

The owners and manager take a personal interest in the safety of their men and the record of injuries shows the close attention devoted to safety matters.

Roof or wall support in drift mines and lode mines in this state, generally speaking, consists of stulls and pillars, although square set

Illustration of slow failure of timbers.

timbers are used in some localities. Cribbing and waste filling are very useful. If the distance between walls is very great, such as it is in many of the Mother Lode mines, stulls are not very effective, but pillars are to be commended. If the pillars are left near enough together so that the wall or vein matter between is arched, the greatest amount of protection is secured under the circumstances. The following view will illustrate this point. This picture was taken in a mine where the conditions for roof support of this kind are ideal, as the hanging wall *is fairly hard and* free from slips.



Mine timbers kept well up to the face of a drift and lagged over.

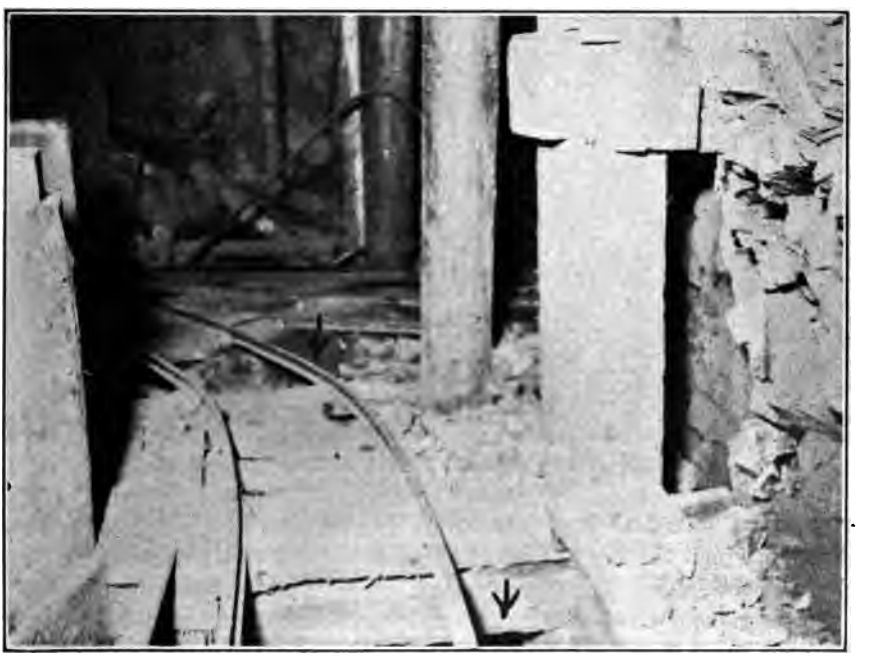
Safety pillars in a large stope, with hard hanging wall.

There is a tendency in some of the mines of the state to draw ore from a shrinkage stope without first trimming all ore or vein matter from the back, and also to neglect sounding the walls for loose slabs as the ore in the stope recedes.

Some mine superintendents do not keep the waste filling in their stopes close enough to the back, consequently it is difficult for the mine foreman or shift bosses to inspect the back for loose rock. Two fatal injuries have recently occurred in mines where the deceased were killed by falls of rock from high backs in stopes.

OPENINGS UNDER FOOT.

Personal falls in the mining industry account for a large percentage of fatal, permanent and temporary injuries. Usually a fall down a vertical shaft or winze results fatally, and it is imperative that all precautions be used to prevent such accidents in shaft repair work or in loading skips. The requirement under section 34 of the Mine Safety



Dangerous holes under foot in a drift.

Rules, which calls for a passageway around a shaft, obviates the necessity of the skip loader passing over the open compartments in order to load skips or use the bell cord.

It is exceedingly bad practice to leave open holes in the bottom of drifts. A miner often finds that his carbide lamp has gone out and he

has no carbide on hand, or his candle has gone out and he has no matches in his clothes, in which case he generally gropes along until he comes to some one who can "fix him up"; and it is while he is walking in the dark that a bad injury is liable to occur in such holes as are shown in the preceding illustration. Ore is dumped into these openings and you will note that there are no grizzlies over them. This is a likely place for a broken leg, arm or rib.

In contrast with the former illustration is shown a well-guarded opening in the bottom of a drift, through which ore is dumped from the ore bins immediately above. Note that the bottom of the drift is boarded

Well-guarded ore chutes on both sides of a drift.

over and a guardrail prevents one from stepping into the open places through which the ore passes. The miner is drawing ore from the ore chute at the left.

In the same class with open ore and waste rock chutes under foot may be mentioned open manways. The Mine Safety Rules require that their collars shall be covered over or surrounded by a railing not less than 3½ feet high.

The comment that ventilation is interfered with by covering over manays is overcome in the following illustration of an open trap door orking on hinges. Pieces of light iron track can be used for this

A well-guarded and ventilated manway. Note that the ladder extends above for some distance. (B. M. Photo.)

urpose, so that it can be lifted from below without difficulty. Care ıould be exercised in arranging, so that the grating will close of its own 'eight; otherwise the miners will not take the trouble to close it.

SHAFT PROTECTION.

Before the Mine Safety Rules became effective, it was very common to see mine shaft collars and shaft stations underground unguarded. Miners have been known to step back into the unguarded shaft to their death. The guardrail should not be too close to the shaft, or yet too far away, so that the space between the railing and the shaft can be used by the men to lounge about in while waiting for the skip at the end of the shift. A railing between compartments should be installed in order to prevent the men from crossing the open compartment after getting out of the skip. The accompanying view shows a substantial

A good shaft collar guardrail left open by the employees. (B. M. Photo.)

rail of iron about the incline shaft, with a rail and pickets between the two compartments. You will notice, however, that all four bars have been left up by the men, who evidently have been loading mine timbers.

The operative part of many of the safety devices must of necessity be left to the employee for whose safety they have been installed by the employer. In this case the men who left the shaft unguarded might be the cause of some man receiving a serious or fatal injury. Eternal vigilance must be the watchword in order to bring safety work to the maximum point of effectiveness; therefore let us all have "safety first" constantly in mind.

The following view shows an underground shaft station in a mine where the width of vein is only a few feet. A man is compelled to stoop

n in order to pass through the station from one side of the shaft he other. Not only is there great danger here from falling into the ft, but there is a danger of drill steel or rock being kicked into the ft. This condition has now been remedied.

A shaft station with no guardrail about the shaft.

MINER'S LIGHTS.

Aside from electric lights which are used for lighting the more per-nent working places in a mine, the carbide lamp is the most econom-l; clean, smokeless, and healthful and is less apt to cause mine fires. s more efficient than either the oil burning lamp or the candle. Like oil burning lamp or candle, it requires oxygen to keep it burning. The oil burning flame is extinguished when the oxygen content of the is reduced to only 17 or 17½ per cent, while the carbide flame is inguished when the oxygen content is reduced to between 12 and 13 cent, *consequently a miner* who goes into bad air will not notice the *t on a carbide lamp* as soon as he will on a candle or oil flame.

[illegible] for hanging miners' lamps in front of an underground magazine.

Carbide must not be stored underground in large quantities and must not be stored near explosives that contain moisture, for the calcium carbide attracts the moisture from the powder and creates an explosive mixture which, if ignited, might explode powder or other explosive mixtures.

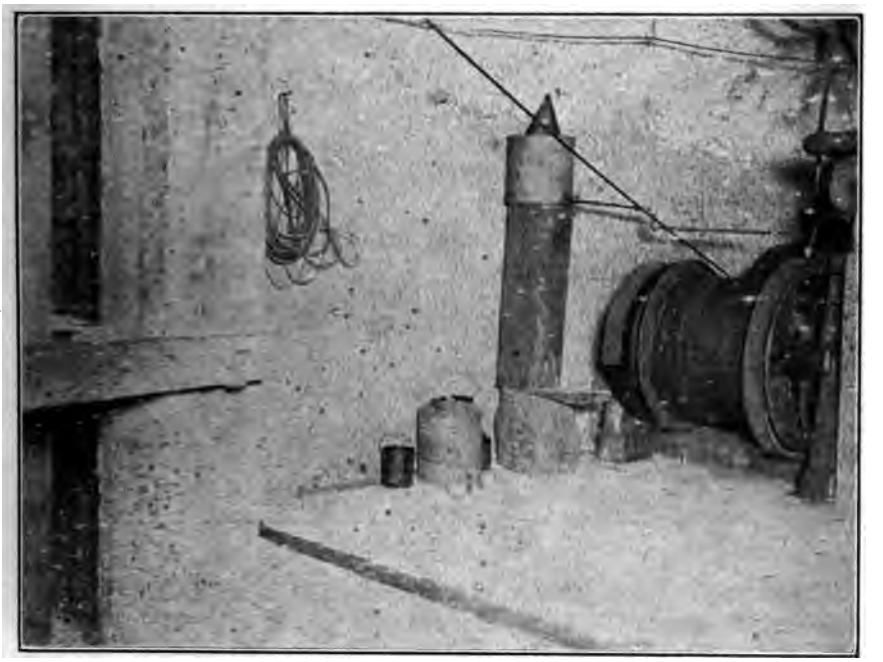
In Section 16 of the Mine Safety Rules it states that miners are not allowed to carry lighted candles or lamps into a magazine. Places for hanging lights outside the magazine must be provided, and the above illustration shows a place for hanging carbide lamps or candlesticks in front of the door of a magazine, so that the light will be thrown into the magazine.

Miners' Circular 18, Bureau of Mines.

INFLAMMABLE MATERIAL.

Under paragraph (*d*), Section 43, of the Mine Safety Rules, it states that the use of gasoline underground is prohibited, except in small quantities, such as is required for blow torches.

About six months ago a man was killed in a California mine by an explosion of gases which accumulated from a gasoline engine used underground for hoisting and pumping purposes. In this case the explosive mixture apparently was caused by a leakage of gasoline about the engine and was ignited by the miner's light. The exhaust from underground stationary or portable gas engines is a source of poisonous

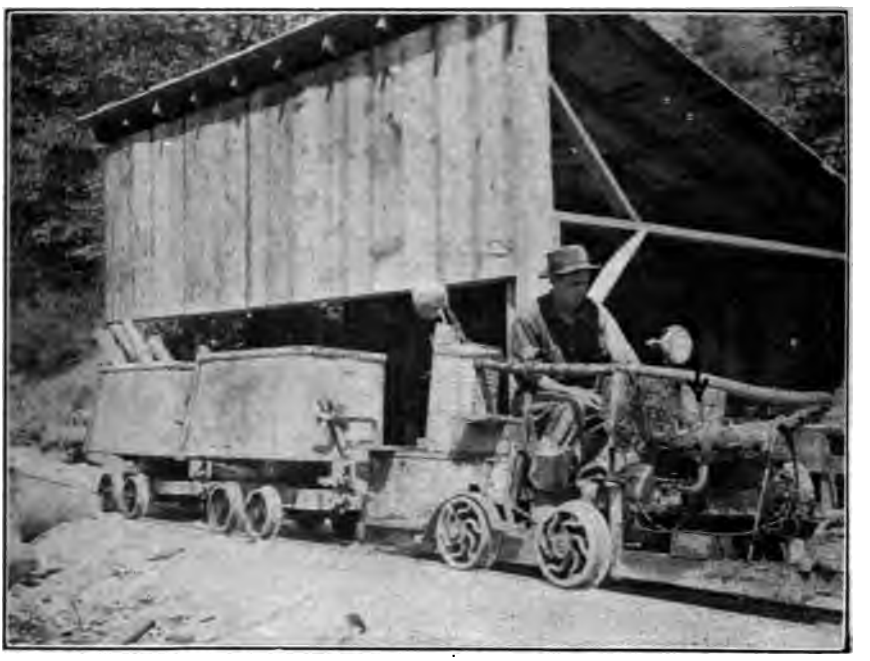


Underground gasoline hoists are prohibited by the mine safety rules.

carbon monoxide. Exhaust gases from stationary engines can be conducted to the surface, but if the conducting pipe becomes defective the air in the mine is liable to become poisoned by the carbon monoxide which is odorless and tasteless, and therefore not readily detected. Valuable reading on this poisonous gas will be found in Technical Paper 115, "Inflammability of Mixtures of Gasoline Vapor and Air," U. S. Bureau of Mines.

Gasoline hoists such as are shown in the above view are dangerous underground if the ventilation is not sufficient to prevent an explosive mixture from collecting and to carry off any carbon monoxide that may find its way into the atmosphere.

The Ford express shown in the following view is also accused of polluting the mine air if sufficient ventilation is not provided. This motor is used for hauling men and mining supplies through a long tunnel and makes on an average of four or five trips through the tunnel during the shift. Note that a one-gallon zerolene can, as shown by the arrow, holds the gasoline supply and a carbide can is used in lieu of a radiator.



Tramming by motor power.

The storage of inflammable material close to mine openings, magazines or buildings is a dangerous procedure and is prohibited within certain bounds by the Industrial Accident Commission in its Mine Safety Rules. In Section 43, paragraph (*a*) of these rules, it says that all oils or other dangerous inflammable materials must be stored in a covered building used solely for that purpose.

The following illustration shows storage of oils in an aerial tramway terminal less than 300 feet from a magazine. This building is constructed of inflammable material and the natural accumulation of oils on the wooden floor increases the fire hazard.

Unsafe practice of storing lubricating oils in mine buildings.

SURFACE MINE MAGAZINES.

The handling of explosives on a large number of mines heretofore has been exceedingly lax and access to powder magazines too easy. Aside from the danger attached to lax methods of handling powder on the surface and underground, the criminal intent of the receiver of explosives might be questioned. Miners have been found to have dynamite in their sleeping quarters, and in one instance the superintendent thought of the idea of storing his small quantity of mine powder in his home. The question of easy access to explosives has become an issue that has now been taken up by the Federal Government, which has passed a law, effective November 15, 1917, compelling manufacturers, vendors and those who buy or receive explosives to possess a license, to keep complete records of the uses to which explosives are put, and to require the return of unused explosives to the magazine. This law will necessitate efficient magazines that are securely constructed and efficiently locked. It provides for a maximum fine of $5,000 and imprisonment for one year for non-compliance with the law.

In the following illustration is an example of a very inefficient magazine, which consists of some old rubber belting thrown over the boxes of dynamite. It is open to anyone who is evilly inclined. The fact that it reposes under an oak tree camouflage does not protect it from harm.

A very unsafe place to store powder.

This surface magazine does not meet any of the requirements of the Mine Safety Rules.

Section 44 of the Mine Safety Rules is worded so that magazines of the first class or those in which over one hundred (100) pounds of explosives are stored shall be both fireproof and bulletproof. Those magazines in which gunpowder or black blasting powder are stored are not required to be bulletproof, but must be fireproof. Magazines of the first class must also be at least 100 feet from any other building.

The preceding illustration shows a very flimsy magazine constructed of one-inch boards, with a shingled roof. The boards have wide spaces between them. This magazine is distinctly not fireproof or bulletproof and is only a few feet from the building which houses the main electric hoist.

A very poor and unsafe magazine.

Aside from the danger to mine employees working in close proximity to explosives, the danger to their families also deserves attention. The magazine shown in the above view is a positive menace to the women and children who live nearby; it also violates all requirements of the Mine Safety Rules.

A concrete magazine of the following type with a heavy iron door, lock and danger sign, built in a safe location, meets the requirements of the law.

About the safest magazine is a tunnel driven into solid ground with offsets in which the explosive is stored. It is not possible for a bullet to pass through the heavy iron door and strike the powder as it is pro-

tected by solid rock in front. An illustration of this type of magazine is shown in the second view following.

A well-constructed fire and bulletproof magazine.

One of the best methods of storing powder. (B. M. Photo.)

UNDERGROUND MINE MAGAZINE.

nderground magazines have been found to be in as poor condition he surface magazines. In many instances powder has been found ed in unused crosscuts or drifts in open powder boxes, with refuse er and remains of powder boxes lying about, which is a dangerous lition. The mine superintendent or foreman often makes the ark, "I have handled powder for thirty years and never had an dent," but it must be remembered that it generally takes only one der accident to end a man's career.

This underground magazine is a menace to the miners.

nused crosscuts or drifts that are supported with dry timbers are fe places for storing powder, especially if the miners persist in ying lights into them. The above view shows a magazine where niners made a practice of eating their lunches. Note that there is oor and that old powder boxes and paper have been allowed to st.

The following view is of a magazine built on a shaft station without door lock and, needless to say, does not meet the requirements of the Mine Safety Rules. The free and easy manner of leaving the powder about for the miners to use as they please does not set a good example to the miner, for he is going to reason that if the owner does not care enough about his powder to lock it up, he certainly is not going to take pains to use it sparingly. With powder at the present high cost, it

The fire hazard is very great in this instance.

should be advantageous to exercise more supervision over its storage and use, even though safety is not considered.

The magazine under consideration is built of lumber and is located on a station that is inflammable. If from any cause the powder should explode, probably one or possibly more men would be killed or injured and there is a chance that the mine shaft would be shattered. In case of a fire the fumes from this powder would prevent men from getting *to the skip in order* to get to the surface, or prevent men from reaching

from without, unless mine rescue apparatus, and trained men to them, were available.

;azines of the first class, which consist of those containing explo- exceeding one hundred (100) pounds, must be fireproof and proof.

following illustration is of an underground mine magazine which ated in an unused crosscut away from the main working places mine, and devoid of timber or other inflammable material, except ooden frame for the front and the heavy wooden door. The door d with sheet iron and the whole front of the magazine is covered

Underground magazine the front of which is covered with thick iron plates.

eavy sheet iron. The powder is stored some distance back of the nd an electric light is installed at least five feet away from the r, thus providing illumination. This mine has similar maga- n other parts of the mine which are under the supervision of the oreman, *who holds* the keys.

CAPS AND FUSE.

Complaints have been made recently that more missed holes occur than formerly. The responsibility for this is hard to place. Most of the mines are now using 6X caps and some using even larger ones. The practice of greasing primers which are to be used in wet holes is not a good one, as the grease injures the fuse. This has been determined by very careful experiments made by the U. S. Bureau of Mines, and disproves the old-time miners' ideas on the subject. There are patented applications to be used for such purposes, or a paint with asphaltum base or even tar may be used without injurious effects.

A fuse cutting and capping station. The box needs a cover and lock.

The cap and fuse locker shown in the above view should have a door which will prevent anything from injuring the caps. Fuse should not be allowed to remain underground in a damp mine longer than seventy-two (72) hours before being used.

The ancient method of using the teeth for crimping caps is not often witnessed now, but occasionally one of the miners with the "experience of thirty years or more" is found, who still insists on the jawbone method; these men should be immediately dismissed.

Cap magazines are required to be fireproof and bulletproof and constructed in like manner as powder magazines, and must be at least one *hundred feet away* from a powder magazine if on the surface, and fifty *feet away if underground*.

The following illustration shows a surface cap magazine built of granite blocks. The door in this instance is constructed of heavy planking and covered with corrugated iron. This cap magazine is located more than the required one hundred feet from a powder magazine.

A surface cap magazine constructed of granite and located at a safe distance from the workings.

CHECK IN AND CHECK OUT SYSTEM.

The attention of those particularly interested in mine safety and efficiency work is directed to a system by which the men can be checked in and out of the mine. Under such a system it is always possible to tell by a glance at the check board just how many men are in the mine and approximately where they are working. This information is of value in connection with cost keeping records, and in the event of men being trapped by reason of a sudden inrush of water, a mine fire, a cave-in, the breakage of hoisting apparatus, or other serious accident. At most mines where the system is used there is a timekeeper's window next to the window where the men go for their carbide or their candles, and as each man passes the timekeeper's window he turns in a numbered brass check which the timekeeper places on the check board. These check boards are sometimes made in the form of very rough models or cross sections of the mine workings, and the checks are placed on the board in positions which correspond roughly to the actual working places of the men employed underground. The practice is excellent from the standpoint of efficiency and makes it possible, when an ac

dent occurs, for the superintendent or manager immediately to know just where his men are working.

PROTECTION OF MINES FROM FIRE.

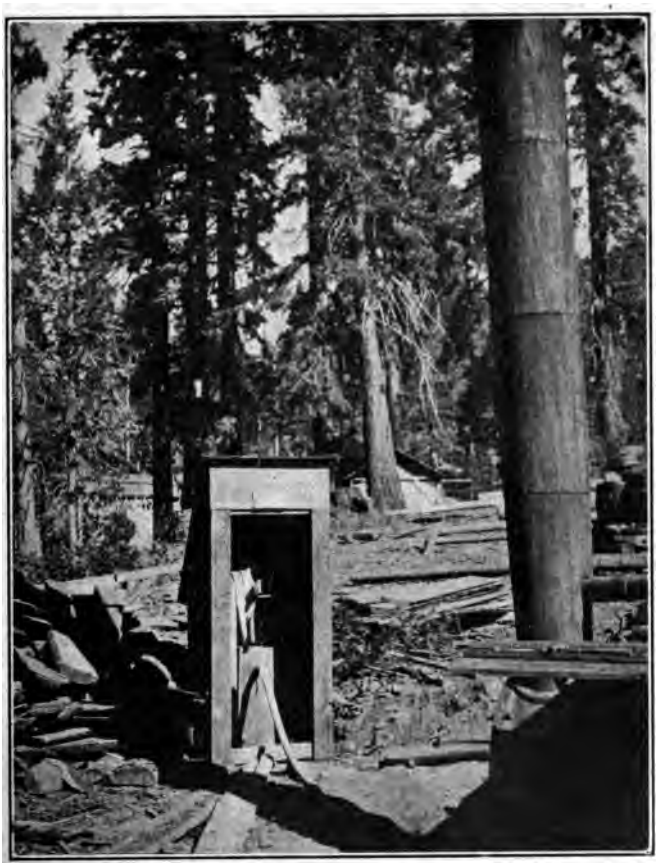
Investigation of the origin of fires in metal mines throughout the United States has unmistakably proved that the miner's candle has been responsible for many of them, but not all. It is also advisable to guard against smoke from a burning surface building being drawn into a mine and smothering men. It is therefore necessary that arrangements be made for protecting the miner while in the mine by using fire doors, chemical extinguishers and water pressure, as well as providing a fire signal and a well-defined understanding as to what the miner is to do when he hears the fire alarm sounded.

In some of the coal mines of the United States safety rooms have been constructed underground that are made as air-tight as possible and from which bore holes extend to the surface, through which fresh air enters and food and water can be sent to the trapped men. No California mines are equipped in this manner; they are being provided with fire doors, chemical extinguishers and water hydrants to comply with the Mine Safety Rules.

The following view shows a high pressure water tank situated on the sidehill above the mine camp, which is supplied with water from the ditch:

Water ditch and tank for camp supply and fire fighting.

m this tank the water is piped to many hydrants located at places there is a fire hazard, such as the sawmill boiler as shown in the ing view.



These hydrants are placed at convenient places for fighting fire on the mine.

third view shows a fire hydrant with hose attached, as shown by row, located near the shaft collar on another mine. In conjunc- ith the water protection there must be a fire door fitted to cover llar of the shaft, and arranged so that it can be closed from a well away from the wooden head-frame.

t least one of the California mines arrangements have been made ify the underground men of the outbreak of a fire or of the ice of other dangerous conditions by suddenly shutting off the essed air from the mine by means of a three-way valve* The men nstructions that when the compressed air is shut off they shall liately proceed to the shaft stations to be hoisted to the surface, or

*ded information on the three-way valve and the proper installation will be given by the ne Inspector on request.

shall make their way to the surface through the escapeways. A fire drill of this kind is held regularly every two weeks, but the men do not know when the drills are to occur. It is suggested that this practice of holding fire drills should be adopted by other mines that have in view the safety of the underground men. The men should be instructed to start out immediately after the compressed air is turned off, and not to return to work until given verbal instructions to do so. In the event of an

A hydrant at the head-frame over the shaft.

actual mine fire, where this signal has been agreed upon, the compressed air should be turned off for only a few minutes, after which it should be turned on and the compressors kept running until all men are out of the mine. In certain instances in the past, men have been trapped behind the smoke from a mine fire and for considerable periods have been dependent on the air received from the compressed air pipes. Therefore it would be a serious error to turn off the compressed air *when a mine fire* started and fail to turn it on again very shortly *afterward.*

SHAFT HEADFRAMES.

great variety of head-frames are to be seen among the mines of rnia, some of modern steel construction and others that stand y by the grace of good luck. The latter kind is illustrated in the ing view of a wooden head-frame over a vertical shaft in which a t is operated. If for any reason the loaded bucket should become

A head-frame which is supplied with wire guy ropes instead of sufficient bracing in the direction of the pull from the engine.

t in the timbers and the power is not shut off immediately, some- would give way in the upper portion above the back bracing. ead-frame is not sufficiently braced to resist the pull in the direc- f the hoisting engine.

In sharp contrast to the head-frame shown in the foregoing picture is the following illustration of a well-braced head-frame in which the compressive stresses downward are provided for in the heavy upright timbers of the head-frame.

A head-frame built to resist the downward thrust.

During a recent inspection trip it was noticed that a new wooden headframe was being erected without any back bracing. The hoisting engine was located on the side hill and not in direct line with the hoisting compartment, but to one side, so that the pull would be about 30° from a line drawn through the front and back of the shaft. It can readily be seen that a disaster would probably have happened if a correction had not been applied.

TRANSFORMERS.

fore the Mine Safety Rules were issued by the State Industrial lent Commission and mining inspectors were appointed to visit s to see that the Rules were being observed, it was common prac- o see transformers placed in exposed places without enclosures of ind. An instance of the kind is shown in the following view:

Unguarded transformers at a mine mill.

guarded transformers such as these are not only dangerous to the vorking on the mine, but are also a source of danger to the public near the mine, especially children.

After calling attention to the requirements under the Mine Safety Rules, the same transformers were entirely enclosed and a fence placed about the building as shown in the following view:

The same transformers housed in and a railing about the housing.

In constructing an enclosure for transformers it is necessary to provide for ample ventilation during the summer months; this is easily done by using heavy wire screen panels on the sides of the enclosure.

UNDERGROUND TROLLEY.

ll underground trolley wires that are within six and one-half (6½) ; of the top of rails must be suitably protected and may be so pro- ed by placing boards on each side of the wires, which boards must end at least three inches below the wires. In new installations all

Underground trolley wire protection.

es that are within seven (7) feet of the top of the rails must be rded in such manner or by some other method which gives the ired protection.

he accompanying underground view shows the board guards placed ach side of the trolley wire. This trolley is placed on one side of tunnel, so that the men are not walking beneath it when entering eaving the mine.

LIST OF SKETCHES OF SAFETY DEVICES.

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California mine operators. In asking for any of the drawings, they may be referred to by number.

No.
1—Arm and Leg Splints.
2—Electric Pull Switch for Mine Bell Signal.
3—Safety Hook for Bucket.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
7—Details of Safety Clutch for Cage.
8—Detail Sketch of Safety Catch for Cage.
9—Safety Catch for Cage.
10—Miscellaneous Parts of Cage.
11—Shaft Cover for Sinking.
12—Safety Crosshead for Bucket.
13—Iron Drill Rack.
14—Lock Hook for Bucket.
15—Grid Iron for Protection at Collar of Ore Chute.
16—Iron Door.
17—Alarm Bell for Cage.
18—Standard Shaft Gate (Swing).
19—Safety Crosshead.
20—Removable Bonnet for Skip.
21—Cover for Skip.
22—Underground Dry Closet.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
26—Semiautomatic Gate for Mine Shafts.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
31—Gate for Shaft Collar.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
35—Cage Safety Catch Testing Device.
36—Safety Cage for Ladders.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
39—Cabinet and Rack for Mine Rescue Apparatus.
40—Change House.
41—Guard for Rip Saw.
42—Riley Two Deck Cage.

43—Automatic Side Dump Car.
(a) Standard Incline Trip.
(b) Draw Bar.
(c) Lower Hinge of Dumping Mechanism.
(d) Door Catch Angles.
(e) Side View, Side Dump Car.
(f) Details.
(g) Details.
(h) Details.
(i) Details.
(j) Details.
44—Plans for Change House.
45—Guard for Tram Car.
46—Underground Latrine.
47—Door for Cage.
48—Warning Bell for Skips and Cages.
49—Shaft Gate.
50—Trolley Support Methods.
51—Underground Toilet Car.
52—Sanitary Dry Closet.
53—Candle Holder for Miners.
54—Toboggan Stretcher for Underground Use.
55—Circular Removable Bonnet for Skips.
56—Toilet Can for Use in Mines.
57—Drinking Water Keg for Use in Mines.
58—Sanitary Mouthpiece for Drinking Water Kegs.
59—Sanitary Toilet for Use in Mines.
60—Signal Bell for Railroad Crossing.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

LIST OF CLIPPINGS.

Air Compressor Cooling with Water Barrels (Illus.).
A Safe Electric Firing Switch.
Ventilating Blowers.
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Drifting with a Stoper (Illus.).
Improved Safety Door for Dumps (Illus.).
Bucket-Dumping Device (Illus.).
A Suspended Car Dump for Tailings.
A Safety Trolley Wire Box.
Device to Aid in Fuse Spitting (Illus.).
Spitting Fuses.
Lacing Method of Making Primers.
Proper Way to Spit Fuses (Illus.).
Some Safety-fuse Pointers.
Clip for Detonator.
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Homemade Thawing Kettle.

Burning Empty Dynamite Cases.
Sand Filling.
A Fire-Bucket Float (Illus.).
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
Electric Hoists for the Michigan Iron Country.
Automatic Landing Chairs (Illus.).
Spillage and Sinking Pocket (Illus.).
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BULLETIN No. 8

RELATING TO

SAFETY REQUIREMENTS

FOR THE

Storage and Use of Explosives in Mines, Quarries and Tunnels

JULY, 1918

Issued by the
Industrial Accident Commission
of the
State of California

In Cooperation with
United States Bureau of Mines

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA

IN COOPERATION WITH UNITED STATES BUREAU OF MINES.

BULLETIN No. 8.

Relating to Safety Requirements for the Storage and Use of Explosives in Mines, Quarries and Tunnels.

By G. CHESTER BROWN, Deputy Mine Inspector.

FOREWORD.

The enactment and the enforcement of the Federal Explosives Law has caused all employers engaged in mining operations to realize the importance of proper supervision over the men in charge of the storage, distribution and use of explosives. This law is more drastic than the one enacted by the State of California; its purpose is to check the activities of those who should not have explosives in their possession.

The Industrial Accident Commission has endeavored, through its Mining Department, to enforce all regulations relating to explosives used in mining operations.

This booklet is issued in accordance with the policy of the Commission to publish bulletins on methods of preventing injuries to employees.

The photographs used in this bulletin were taken in the field during inspection trips.

Acknowledgment is made of the courtesy of the Coast Manufacturing and Supply Company in supplying the data contained herein, in regard to fuse, and furnishing the cuts to illustrate the same.

REQUIREMENTS OF THE FEDERAL EXPLOSIVES LAW THAT RELATE TO MINING OPERATIONS.

1. No person can issue or sell explosives without a license.

2. The person issuing explosives shall see that any unused explosives, or ingredients, are returned, and that no explosives or ingredients, are taken by the workman to any point not necessary to the carrying on of his duties.

3. Every person authorized to sell, issue, or dispose of explosives shall keep a complete, itemized and accurate record, showing to whom explosives are sold, given or bartered, or to whom or how otherwise disposed of, and the quantity and kind of explosives, the date of each such sale, gift, barter or other disposition, and this record shall be sworn to and furnished to the Director of the Bureau of Mines, or his authorized representative, whenever requested.

4. Licenses shall only be issued to citizens of the United States of America, and to the subjects or citizens of nations that are at peace with them, and to corporations, firms and associations thereof.

5. It shall be unlawful for any person to represent himself as having a license issued under this Act, when he has not such a license, or as having a license different in form from the one which he in fact has.

6. Every person authorized under this Act to store explosives or ingredients shall clearly mark and define the premises on which his magazine may be, and shall conspicuously display thereon the words, "Explosives—Keep Off."

7. Except duly authorized government or state officials, no person, without the consent of the owner or his authorized agents, shall be in or upon any premises on which explosives are stored; nor shall any person discharge any fire arms or throw or place any explosives or inflammable bombs at, or against any magazine premises, or cause the same to be done.

8. The Director of the Bureau of Mines is authorized to make rules and regulations for carrying into effect this Act, subject to the approval of the Secretary of the Interior.

9. Any person violating any of the provisions of this Act or any rules or regulations made thereunder, shall be guilty of a misdemeanor and shall be punished by a fine of not more than $5,000 or by imprisonment not more than one year, or by both such fine and imprisonment.

NOTE.—John M. Griffin, Madera, Cal., is U. S. Explosives Inspector for the State of California.

Special Rules for Mining Operations.

Every owner or operator of a mine, quarry or other industry using explosives or ingredients will require:

(*a*) A purchaser's license, when explosives are bought for use only by his employees, and for delivery to them at the mine or quarry, or

(*b*) A vendor's license, where explosives are bought for resale even in part, for use away from the mine or quarry.

(*c*) Every owner or operator of a mine, quarry or other work shall require all employees who are charged with the custody or distribution of explosives to have a foreman's license. No unlicensed employee shall issue or distribute explosives.

The premises upon which each magazine is located must be marked, "Explosives—Keep Off." The magazine shall be in charge of one person and at all times kept securely locked, except when explosives are being put into storage in it or issued from it.

Emphasis is placed on the fact that all forms of fuse, squibs, caps and detonators are classed as explosives under the law.

Rules for the Storage of Explosives.

All explosives to the extent of 25 pounds* or less, may be stored in strongly constructed wooden boxes which must be kept securely locked at all times except when being filled or emptied, and which should, whenever possible, be placed in a securely locked building.

All hasps, staples and hinges on magazines, or storage boxes must be attached by rivets or by bolts with washers and nuts, the nuts to be placed inside of the boxes.

The storage of a small amount of explosives, one day's supply, in mines, quarries and tunnels, shall be carefully supervised by the superintendent. The properly constructed boxes for holding explosives shall not be placed near a haulageway, or along places where employees travel, or at any place where its accidental discharge would cut off the escape of men from their working places.

The United States Explosives Inspector in each state, working in cooperation with his advisory committee, shall have the right to require the making of whatever changes in construction, location, or safeguarding, may be necessary for the proper protection of the contents and of surrounding property. Guards may be ordered placed, temporarily or permanently, at any magazine. Appeal may be made from any decision of the U. S. Inspector, to the Director, Bureau of Mines, Washington, D. C.

*The Advisory Committee for the U. S. Explosives Inspector for California has decided that at mines and quarries in California 100 pounds or less, of explosives may be stored in properly constructed locked boxes. The officials of the Bureau of Mines have informally approved of this decision.

MAGAZINES.

Properly constructed magazines for the storage of explosives are not only required by Federal and State Laws, but are of great importance for the safe operation of any industry in which explosives are used. Magazines should be bullet and fire proof, dry and well ventilated. In many cases, a magazine has been constructed by driving a tunnel into the side of a hill, but no provision has been made for drainage, or

A well constructed fire and bullet proof concrete magazine.

ventilation. Unless the soil is impervious to water, moisture will collect in such a magazine and cause the explosives to deteriorate; such deterioration may affect the safety or the efficiency of an explosive.

TYPE OF CONSTRUCTION THAT SHALL BE USED FOR FIREPROOF AND BULLETPROOF MAGAZINES.

The following specifications for magazine construction shall apply only to magazines under construction or contemplated, or such magazines as may be found unsafe:

Roof.

1. As given in Technical Paper 18—Magazines and Thaw Houses for Explosives, issued by the U. S. Bureau of Mines (see figure 2, page 19). Copies of T. P. 18 may be obtained from the Industrial Accident Commission.)

An artificial barricade built around a powder magazine.

2. Tongue and groove material covered with one layer of brick* 2½ inches thick and covered with 6 inches of dirt. Above the dirt shall be placed rough boards covered with not lighter than No. 26 corrugated iron or No. 26 flat galvanized iron.

NOTE.—The quantity and distance table governing the keeping of explosives, effective January 1, 1919, has been added to the State Explosives Act under Section 3, subsection (*b*). The provisions of subsection (*b*) do not apply to mine or quarry operations.

Walls.

Walls shall be constructed to comply with the description below:

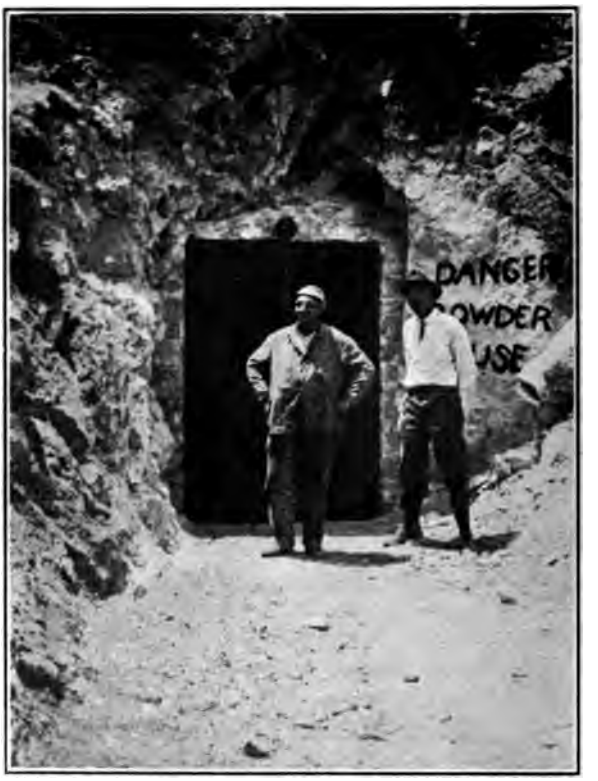
1. Brick walls 8 inches thick.*

2. Sand or gravel filled walls, in which the space for sand or gravel is at least 8 inches (preferably 10 inches), thick; sand or gravel to be well tamped; largest piece of gravel to be not more than 1 inch in

*NOTE.—Although the State Law and the recommendations of the Advisory Committee of the U. S. Explosives Inspector for California permit the use of brick in magazine construction, the practice is not recommended on account of the danger of flying fragments if an explosion should occur in magazine. The U. S. Bureau of Mines urgently recommends that brick should not be used in magazine construction.

diameter; inside lining of wall to be tongue and groove material; outside wall to be covered with no less than No. 26 corrugated galvanized iron.

3. Wood studding covered with sheet iron may be used, but if this type of construction is used, there must be a complete natural or artificial barricade to protect from bullets and bullet proof doors must be used, as outlined in the following.



A magazine made by driving a tunnel into the side of of a hill. A magazine of this kind should be dry and well ventilated.

4. If cement mortar magazine is constructed it must be built as per U. S. Bureau of Mine specifications as given in Technical Paper 18.

Ventilators.

Ventilators must be placed underneath the floor. There must also be side and top ventilation. Side ventilators must not be direct. (U. S. Bureau of Mines or Institute of Makers of Explosives specifications will be permitted.)

Floor.

The floor must be constructed of tongue and groove material and must stand at least 2 feet off the ground.

oor.

To be bullet proof, doors must be constructed of 3-inch hardwood, vered with ⅜-inch steel plate. If it is not desired to use bullet-proof ors, bullet-proof wing walls may be placed in front of a nonbullet-oof door, in which event the door must be covered with not less than). 26 galvanized iron and the wing walls must be so placed as to ake it impossible to shoot through the door. Cement mortar doors as r U. S. Bureau of Mines specifications (Technical Paper 18, may be ed.

This surface magazine does not meet any of the Federal or State requirements. It is an old wooden building within 50 feet of the hoist house.

ck.

A suitable heavy rim lock shall be used on the inside of the door, or suitable heavy mortise lock may be used in place thereof.

gns.

The premises on which explosives or ingredients that are in themves explosive, are stored must be conspicuously defined and marked signs containing the words "Explosives—Keep Off." Such signs ust not be placed on the magazine and must be so located that a bullet ssing through the sign will not strike the magazine. Magazines which e now safely constructed and already have the prescribed signs amely the words "Magazines, Explosives, Dangerous" in letters not s than 6 inches high) upon the four walls thereof, will be con-ered as complying with this rule.

Fuse.

Fuse should be stored in securely locked, suitable magazines with proper signs. Suitable fuse magazines for large quantities of fuse must be protected against theft, but need not be fire proof or bullet proof. Fuse may be stored with dynamite in a fire proof magazine. Not to exceed 6,000 feet of fuse may be stored in securely locked, metal covered or metal lined boxes, and all precautions against theft that are required in the case of high explosives must be taken to protect the fuse.

Detonators, or other devices containing fulminating composition shall not be kept in a magazine in which there are explosives, but shall be stored in securely locked, suitable magazines, with proper signs. The magazine for detonators shall be placed a safe distance from any other magazine.

PRECAUTIONS THAT SHALL BE OBSERVED IN THE USE OF EXPLOSIVES.

1. When supplies of explosives or fuse are removed from a magazine, those that have been longest in the magazine shall be taken first. Packages of explosives shall be removed to a safe distance from the magazine before being opened, and no such packages shall be opened with any metallic instrument.

2. Magazines shall at all times be kept clean and dry and free from grit. Before any alterations are made to any part, thereof, all explosives shall be carefully removed and the magazine thoroughly

A very unsafe method of storing powder, which violates all Federal and *State requirements.* (Underground photograph.)

washed out. All tools and instruments used in making repairs shall be of wood, copper, brass, or other soft metal or material. In no case shall nails or screws be driven into a magazine or into material that has once formed a part of a magazine, and all wooden parts discarded shall be burned in a safe place immediately.

3. No detonator shall be stored within fifty feet of other explosives underground. No detonator shall be transported with other explosives except when being carried to the face for immediate use.

4. All primers and capped fuses shall be exploded within thirty-six hours after making. This does not include delay action electric

A very unsafe method of storing explosives. (Underground photograph.) All Federal and State requirements have been violated. Primers are stored within 20 feet of the powder; 350 primers and 1 ton of powder. Note the locker in which tools and clothes are stored by employees. Also the vice attached to a workbench.

exploders. Detonators shall not be removed from original containers except as they are used for capping fuses.

5. Explosives shall not be carried underground on an electric locomotive and no one except the train crew shall be allowed to ride on a train carrying explosives.

6. Explosives shall not be placed or left within five feet of live electric wires.

7. Smoking in a powder magazine, at a powder distributing station, or while handling powder shall be strictly forbidden.

8. The thawing of explosives shall be done in accordance with the instructions given in Bureau of Mines publication (Technical Paper 18, pp. 23-33), and the California Mine Safety Rules (pp. 62-63).

BLASTING.

1. (*a*) Bosses or shot firers shall be in immediate charge of and responsible for blasting in all mining operations. Wooden tamping rods, with no metal parts, shall be used in tamping explosives or tamping material in the bore holes, and it shall be the duty of the bosses or shot firers to see that no metal tools are used for tamping. It shall be the duty of the foreman to fix the time of all blasting and firing. Bosses or shot firers and miners about to fire shots shall cause warning to be given in every direction and all entrances to the place or places where charges are to be fired shall be guarded so far as possible. Detonators, when used in firing blasts, shall be of not less strength than No. 6, containing one gram of fulminating composition.

(*b*) A bronze, wooden or heavy paper funnel shall be used to load bore holes when black powder or other bulk powder is employed.

2. No person shall extract, or attempt to extract explosives from a misfired hole, but, when possible, a new primer shall be put in and the charge blasted again. When not possible to explode the charge with a new primer, a new hole shall be drilled, which must not be nearer to the original hole than two (2) feet and shall be pointed at such an angle as to eliminate all danger of its meeting or coming closer to the other hole than two (2) feet, and such new hole shall be charged with a fresh charge of explosives and then detonated; *provided,* that when the above can not be complied with, a hole nearer than two (2) feet may be drilled under the direct supervision of the superintendent or foreman.

(Note: When drilling near a misfired hole which has been sprung care should be taken that the drill is so directed as to minimize the danger of its coming in contact with the sprung portion of the hole.)

3. When electricity is used to fire shots, it shall not be permitted for any person knowingly to enter the vicinity of the place where such shots have been fired, until the cable from the source of electrical energy to the blasted holes shall have been disconnected and short circuited. It shall be the duty of the boss or shot firer to see that all such cables are disconnected immediately after such firing, and to examine or direct such examination of such place where shots have been fired before any men are permitted to work therein.

4. It shall be the duty of the boss or shot firer to see that special precautions are taken against the shot firing cables or wires coming into contact with the lighting, power or other circuits, or with any metal pipe lines. All portable devices for generating or supplying electricty for shot firing shall be in charge of a boss or shot firer. No person other than a boss or shot firer shall connect the firing machine or battery to the shot firing leads, and such connection shall not be made *until* all other steps preparatory to the firing of a shot shall have been *completed, and the* men removed to a safe distance. Batteries used

for shot firing shall be provided with a suitable case in which all contacts shall be made or broken, except that the binding posts for making connections to the firing leads may be outside.

5. Electricity from light or power circuits shall not be used for firing shots, except where the electrical connections to such light or power circuits are made within an inclosed switch box, which shall be kept securely locked and shall be accessible only to the authorized boss or shot firer.

For information on the general subject of storing and handling explosives, the publications listed below, which may be obtained free of cost on request to the Director of the U. S. Bureau of Mines, Washington, D. C., are of interest.

Technical Paper 18, Magazines and Thaw Houses for Explosives, by C. Hall and S. P. Howell.

Bulletin 80, A Primer on Explosives for Metal Miners and Quarrymen, by C. E. Munroe and C. Hall.

Miners' Circular 19, The Prevention of Accidents from Explosives in Metal Mining, by Edwin Higgins.

Another publication, *Standard Storage Magazines* recommended by The Institute of Makers of Explosives, U. S. A., which may be obtained from powder companies, is of interest.

PRECAUTIONS TO BE USED TO PREVENT MISFIRES.

Many accidents have resulted from missed holes, which might have been avoided if proper precautions had been taken to ascertain that the powder, caps and fuse were in good condition before being used, and that the primer had been properly made.

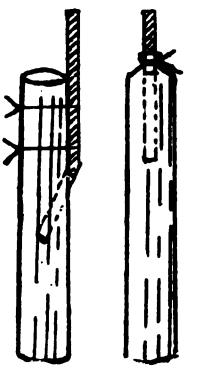
Of the 60 fatal accidents reported in California mines, quarries and tunnels during the year 1917, six of them resulted from missed holes.

Mr. Edwin Higgins in Bulletin No. 2, Relating to Safety and Efficiency in Mines, issued by the Industrial Accident Commission, states in discussing Accidents from Misfires, that "of the ten fatal accidents reported in California mines during the first four months of 1916, three of them resulted from missed holes. In addition to these fatalities, several men were seriously injured. Such a large percentage of accidents from misfires is unusual."

"There are many things to be considered in the prevention of accidents of this nature. In the first place, it is necessary that powder, caps and fuse be of good quality. The storage and care of explosives have much to do with their action when put in use. They should not be stored in damp places, nor exposed to dampness after removal from the magazine. Fuse should be observed closely to see that it is not damaged. It should be freshly cut when put into the cap. Capping fuse more than 36 hours before using it is poor practice. All explosives should be used as soon as possible after removal from the magazine.

"If the face to be blasted is very wet, it is important that holes be not loaded too great a length of time before blasting. In wet places care should be taken to protect the joint between the cap and fuse. The use of oil or grease for this purpose is very objectionable, for the burning fuse, coming in contact with such material, causes it to form a spray which may easily cause a misfire. Fuse manufacturers supply a satisfactory compound for water-proofing. Also, there is on the market a rubber covering for protecting the cap from moisture.* Good roofing paint gives satisfactory results. Ordinary white laundry soap will water-proof a joint for a short period of time.

"The making of the primer is a very important consideration. The United States Bureau of Mines has made many and extended tests to determine the best method of making primers. Without going into detail, it may be said these results showed that any method of making the primer necessitating the bending of the fuse at a sharp angle is very undesirable. The double lace, or placing the cap in the bottom of the cartridge and bending the fuse back through 180 degrees, are objectionable. The two methods that resulted in by far the minimum of misfires under all conditions are shown in the accompanying sketch.



Two methods of making a primer that gave the least number of misfires in Bureau of Mines tests.

The Handling of Missed Holes.

"After everything possible has been done to insure the proper detonation of the charge, the next matter of importance is to see that misfired holes are handled safely. This appears to be simple enough, but any method that may be devised brings into consideration the human element. There will always be men who, from time to time, will violate rules. Frequently an experienced man will take even greater chances than will a greenhorn. Men who have spent almost a lifetime handling powder have been killed as a result of misfires. In many cases familiarity with powder causes a man to regard danger lightly.

*Author's Note: Recent U. S. Bureau of Mines tests show that this device is not *effective.*

"It is second nature to most miners to count the number of reports from a round of holes. It is at this point, however, that many misfire accidents originate. The miner either goes back to a missed hole too soon or he fails to report the misfire. If he does report it, there often develops some mistake in transmitting the information to the proper man on the next shift. The following plan has been found satisfactory in handling misfires: See that miners count the number of blasts and, if the entire round has not exploded, provide means so that a report can be made to the shift boss of the next oncoming shift as to the number and location of the missed holes. A record may be kept on a bulletin board either underground, or in the change house. Some companies provide printed forms and cause their miners to report misfires to the shift boss, who in turn delivers the printed report to the shift boss of the next oncoming shift.

"Misfired holes should be handled under the supervision of the shift boss, or some one experienced in this class of work. To insure safety in recovering a missed hole, the following procedure should be observed: Under no circumstance should any one be allowed to return to the face within 45 minutes of a misfire. An attempt should first be made to fire the missed hole by means of a new primer. If this is not possible, or if it fails, a new hole should be drilled at least two feet from the missed hole in such a direction that it will not encounter the defective charge in the old hole.

"The only method of insuring compliance with requirements laid down for the proper handling of missed holes is to use the strictest discipline in every case of disobedience to rules. No matter how valuable a miner may be, he is a menace to himself and those working with him, if he will not use care in the handling of missed holes.

"The above short discussion relates chiefly to the prevention and safe handling of misfires."

REGULATIONS FOR THE USE OF FUSE.

1. No fuse shall be used for blasting that burns faster than one (1) foot in thirty (30) seconds or slower than one (1) foot in fifty-five (55) seconds.

Under no circumstances shall fuse less than two and one-half ($2\frac{1}{2}$) feet long be used.

2. The use of oil or grease to waterproof joints between cap and fuse is forbidden. (*This practice causes misfires. The use of a compound sold by powder manufacturers for waterproofing, such as roofing paint, celakap, etc., is recommended.*)

3. In capping fuse, at least one (1) inch shall be cut from the end of each coil of fuse to be used in blasting. (*This will prevent damp fuse ends from getting into the cap.*)

4. Only a broad jaw crimper shall be used for attaching fuse to blasting cap. Crimping with the teeth or a knife is strictly forbidden. Crimpers shall be provided and kept in good repair ready for use.

5. It is forbidden to use fuse that has been hammered or injured by falling rocks or from any other cause. (*Such injury may increase the rate of burning, or may render the fuse entirely useless.*)

6. In cold weather fuse shall be warmed slightly before uncoiling, to avoid cracking the fuse.

7. The hanging of fuse on nails or other projections which causes a sharp bend to be formed in the fuse is prohibited.

8. Care shall be taken that only a sharp cutting edge is used to cut the fuse before crimping. (Note: A dull edge makes an irregular cut and is liable to cause a misfire.)

FUSE.

Abuses, Storage, Crimping, Etc.

GENERAL INSTRUCTIONS.

Abuses.

A matter to which it is well to call the attention, is the abuse to which fuse is subjected by the men, in all good faith, through a misconception of the waterproofing quality of "axle grease" or "crude oil" when applied to the outside of a fuse when capped, in order to make a so-called "waterproof joint."

Grease and oil being solvents of the fuse varnishes, destroy the powder train in the fuse, with as great, if not greater, rapidity than would the water which the men are trying to exclude.

Storage.

Fuse should be stored in a dry room, so that the powder may not be affected by dampness. It should also be kept cool so that the varnish will not become sticky. A simple method of ascertaining whether or not a room is sufficiently free from dampness so that fuse may be safely stored therein, is to place a salt shaker, containing common table salt, in the room in which the fuse is to be stored. If at the end of sixty hours the salt can be easily shaken from the saltcellar, the storeroom is dry enough to make an ideal place for the storage of fuse.

When fuse is stored where climatic conditions make it impossible to keep the fuse at a higher temperature than 32 degrees F. the fuse should be warmed slightly before uncoiling, to avoid the danger of breaking. If the fuse is uncoiled when too cold, it will break.

Care should be taken not to allow any oily or greasy matter to come in contact with fuse, as oil will rapidly penetrate the varnish and ruin the powder train.

Waterproof Varnishes.

The ordinary varnishes used on taped fuses are more or less subject to climatic conditions. Extreme heat will cause them to melt and make the fuse sticky, while extreme cold will cause them to crack open so as to admit water. These difficulties can be overcome to a large extent, and better satisfaction can be afforded if the manufacturers have a previous knowledge of the climate where the fuse is to be used. The tendency to crack can be checked by warming slightly just before using, and the stickiness can be remedied by applying a little whiting, flour or any similiar substance.

Burning Speed.

In recent years there has been a growing demand, in some markets, for a slow burning fuse. Doubtless this arises from a desire to economize, but, when carried to extremes it is false economy. Both safety and certainty require a regular and strong burning fuse that will give a long "spit" at the end, insuring the certain discharge of the cap. On the other hand, very rapid burning fuse causes "snapping" and irregular speed.

Preparation for Use.

To remove the required length from a coil of fuse, always uncoil from the outside to the center of the coil. This method will avoid the tendency to recoil or kink, and will leave the remainder of the coil undisturbed. For cutting the fuse use a sharp knife or other cutting instrument that has a clean, sharp edge. If the blasting agent is a high explosive, a detonating cap, made expressly for the purpose, must be used. In tamping use only a wooden "tamping" bar.

Crimping.

For "crimping" use a Crimper that has a broad crimping surface.

Avoid a crimper that has a narrow jaw.

Waterproofing.

In wet work, for waterproofing the joint at the point where the cap is crimped to the fuse, use a paint with an asphaltum base.

Capping the Fuse.

To stick the end of a piece of fuse into a blasting cap. Could anything be simpler? But let's see. The blasting cap is filled with a compound which is exceedingly sensitive to blows, friction or heat. It is very unsafe to punch, poke or stick anything into this composition.

It is necessary then for the end of the fuse to be cut off square across like this:

This makes a smooth, even end which can, with safety, be inserted into the cap till it touches the composition. There will not be any chance for the sparks that shoot out of the end of the fuse, when it burns to the end, going anywhere except into the cap composition and igniting it.

Careless blasters often coil the fuse around their arm like coiling up a clothes line. Then they cut it with a knife and it makes a sharp point like this:

Unfortunately it is easier to make a slanting or pointed cut than one square across, and cutting fuse properly with a pocket knife is not easy.

The trouble with the pointed cut is that the sharp point of a hard piece of fuse is not particularly safe to jab into a blasting cap, and if the point happens to be soft, as it is in warm weather, it is liable to turn over like this:

so that the sparks will shoot against the side of the cap instead of into the composition, and so cause a misfire.

Misfires are usually blamed on the fuse, whereas they are very often the fault of the man who caps the fuse.

Perhaps the best tool for cutting safety fuse is a pair of good sharp pruning shears. They must be sharp or they will make a ragged cut.

Use Care in Preparing Safety Fuse for Blasting.

One inch should be cut from the end of each length of fuse to be used in blasting. This will prevent damp fuse ends from getting into the cap.

Always insert the fuse the full length of the barrel of the blasting cap before crimping.

Always use a broad jawed crimper for attaching fuse to blasting cap; never use a knife or your teeth.

Do not allow the fuse to remain in hot, damp or oily places. Fuse demands cool, dry storage.

Do not cut fuse short to save time; it is dangerous economy.

Preparing Fuse for Use in Wet and Damp Work.

In wet work be sure to have a thoroughly waterproof connection between the blasting cap and fuse. Use a preparation such as "Celakap" or asphaltum base roofing paint which contain neither grease nor oil.

Federal Explosives Law.

[PUBLIC—No. 68—65TH CONGRESS.]

[H. R. 3932.]

An act to prohibit the manufacture, distribution, storage, use and possession in time of war of explosives, providing regulations for the safe manufacture, distribution, storage, use, and possession of the same, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That when the United States is at war it shall be unlawful to manufacture, distribute, store, use, or possess powder, explosives, blasting supplies, or ingredients thereof, in such manner as to be detrimental to the public safety, except as in this Act provided.

SEC. 2. That the words "explosive" and "explosives" when used herein shall mean gunpowders, powders used for blasting, all forms of high explosives, blasting materials, fuses, detonators, and other detonating agents, smokeless powders, and any chemical compound or mechanical mixture that contains any oxidizing and combustible units, or other ingredients, in such proportions, quantities or packing that ignition by fire, by friction, by concussion, by percussion, or by detonation of, or any part of the compound or mixture may cause such a sudden generation of highly heated gases that the resultant gaseous pressures are capable of producing destructive effects on contiguous objects, or of destroying life or limb, but shall not include small arms or shotgun cartridges: *Provided,* That nothing herein contained shall be construed to prevent the manufacture, under the authority of the Government, of explosives for, their sale to or their possession by, the military or naval service of the United States of America.

SEC. 3. That the word "ingredients" when used herein shall mean the materials and substances capable by combination of producing one or more of the explosives mentioned in section one hereof.

SEC. 4. That the word "person," when used herein, shall include States, Territories, the District of Columbia, Alaska, and other dependencies of the United States, and municipal subdivisions thereof, individual citizens, firms, associations, societies and corporations of the United States and of other countries at peace with the United States.

SEC. 5. That from and after forty days after the passage and approval of this Act no person shall have in his possession or purchase, accept, receive, sell, give, barter or otherwise dispose of or procure explosives, or ingredients, except as provided in this Act: *Provided,* That the purchase or possession of said ingredients when purchased or held in small quantities and not used or intended to be used in the manufacture of explosives are not subject to the provisions of this Act: *Provided further,* That the superintendent, foreman, or other duly authorized employee, at a mine, quarry, or other work, may, when licensed so to do, sell or issue, to any workman under him, such an amount of explosives, or ingredients, as may be required by that workman in the performance of his duties, and the workman may purchase or accept the explosives, or ingredients, so sold or issued, but the person so selling or issuing same shall see that any unused explosives, or ingredients, are returned, and that no explosives, or ingredients, are taken by the workman to any point not necessary to the carrying on of his duties.

SEC. 6. That nothing contained herein shall apply to explosives or ingredients while being transported upon vessels or railroad cars in conformity with statutory law or Interstate Commerce Commission rules.

SEC. 7. That from and after forty days after the passage of this Act no person shall manufacture explosives unless licensed so to do, as hereinafter provided.

SEC. 8. That any licensee or applicant for license hereunder shall furnish such information regarding himself and his business, so far as such business relates to or is connected with explosives or ingredients at such time and in such manner as the Director of the Bureau of Mines, or his authorized representative, may request, excepting that those who have been or are at the time of the passage of this Act regularly engaged in the manufacture of explosives shall not be compelled to disclose secret processes, costs, or other data unrelated to the distribution of explosives.

SEC. 9. That from and after forty days after the passage and approval of this Act every person authorized to sell, issue, or dispose of explosives shall keep a

complete itemized and accurate record, showing each person to whom explosives are sold, given, bartered, or to whom or how otherwise disposed of, and the quantity and kind of explosives, and the date of each such sale, gift, barter, or other disposition, and this record shall be sworn to and furnished to the Director of the Bureau of Mines, or his authorized representatives, whenever requested.

SEC. 10. That the Director of the Bureau of Mines is hereby authorized to issue licenses as follows:

(*a*) Manufacturer's license, authorizing the manufacture, possession, and sale of explosives and ingredients.

(*b*) Vendor's license, authorizing the purchase, possession, and sale of explosives or ingredients.

(*c*) Purchaser's license, authorizing the purchase and possession of explosives and ingredients.

(*d*) Foreman's license, authorizing the purchase and possession of explosives and ingredients, and the sale and issuance of explosives and ingredients to workmen under the proviso to section five above.

(*e*) Exporter's license, authorizing the licensee to export explosives, but no such license shall authorize exportation in violation of any proclamation of the President issued under any Act of Congress.

(*f*) Importer's license, authorizing the licensee to import explosives.

(*g*) Analyst's, educator's, inventor's, and investigator's licenses, authorizing the purchase, manufacture, possession, testing, and disposal of explosives and ingredients.

SEC. 11. That the Director of the Bureau of Mines shall issue licenses, upon application duly made, but only to citizens of the United States of America, and to the subjects or citizens of nations that are at peace with them, and to corporations, firms, and associations thereof, and he may, in his discretion, refuse to issue a license, when he has reason to believe, from facts of which he has knowledge or reliable information, that the applicant is disloyal or hostile to the United States of America, or that, if the applicant is a firm, association, society, or corporation, its controlling stockholders or members are disloyal or hostile to the United States of America. The director may, when he has reason to believe on like grounds that any licensee is so disloyal or hostile, revoke any license issued to him. Any applicant to whom a license is refused or any licensee whose license is revoked by the said director may, at any time within thirty days after notification of the rejection of his application or revocation of his license, apply for such license or the cancellation of such revocation to the Council of National Defense, which shall make its order upon the director either to grant or to withhold the license.

SEC. 12. That any person desiring to manufacture, sell, export, import, store, or purchase explosives, or ingredients, or to keep explosives or ingredients in his possession, shall make application for a license, which application shall state, under oath, the name of the applicant; the place of birth; whether native born or naturalized citizen of the United States of America; if a naturalized citizen, the date and place of naturalization; business in which engaged; the amount and kind of explosives or ingredients which during the past six months have been purchased, disposed of, or used by him; the amount and kind of explosives or ingredients now on hand; whether sales, if any, have been made to jobbers, wholesalers, retailers, or consumers; the kind of license to be issued, and the kind and amount of explosives or ingredients to be authorized by the license; and such further information as the Director of the Bureau of Mines may, by rule, from time to time require.

Applications for vendor's, purchaser's, or foreman's licenses shall be made to such officers of the State, Territory, or dependency having jurisdiction in the district within which the explosives or ingredients are to be sold or used, and having the power to administer oaths as may be designated by the Director of the Bureau of Mines, who shall issue the same in the name of such director. Such officers shall be entitled to receive from the applicant a fee of 25 cents for each license issued. They shall keep an accurate record of all licenses issued in manner and form to be prescribed by the Director of the Bureau of Mines, to whom they shall make reports from time to time as may be by rule issued by the director required. The necessary blanks and blank records shall be furnished to such officers by the said director. Licensing officers shall be subject to removal for cause by the Director of the Bureau of Mines, and all licenses issued by them shall be subject to revocation by the director as provided in section eleven.

SEC. 13. That the President, by and with the advice and consent of the Senate, may appoint in each State and in Alaska an explosives inspector, whose duty it shall be, under the direction of the Director of the Bureau of Mines, to see that

this Act is faithfully executed and observed. Each such inspector shall receive a salary of $2,400 per annum. He may at any time be detailed for service by said director in the District of Columbia or in any State, Territory, or dependency of the United States. All additional employees required in carrying out the provisions of this Act shall be appointed by the Director of the Bureau of Mines, subject to the approval of the Secretary of the Interior.

SEC. 14. That it shall be unlawful for any person to represent himself as having a license issued under this Act, when he has not such a license, or as having a license different in form or in conditions from the one which he in fact has, or without proper authority make, cause to be made, issue or exhibit anything purporting or pretending to be such license, or intended to mislead any person into believing it is such a license, or to refuse to exhibit his license to any peace officer, Federal or State, or representative of the Bureau of Mines.

SEC. 15. That no inspector or other employee of the Bureau of Mines shall divulge any information obtained in the course of his duties under this Act regarding the business of any licensee, or applicant for license, without authority from the applicant for license or from the Director of the Bureau of Mines.

SEC. 16. That every person authorized under this Act to manufacture or store explosives or ingredients shall clearly mark and define the premises on which his plant or magazine may be and shall conspicuously display thereon the words "Explosives—Keep Off."

SEC. 17. That no person, without the consent of the owner or his authorized agents, except peace officers, the Director of the Bureau of Mines and persons designated by him in writing, shall be in or upon any plant or premises on which explosives are manufactured or stored, or be in or upon any magazine premises on which explosives are stored; nor shall any person discharge any firearms or throw or place any explosives or inflammable bombs at, on, or against any such plant or magazine premises, or cause the same to be done.

SEC. 18. That the Director of the Bureau of Mines is hereby authorized to make rules and regulations for carrying into effect this Act, subject to the approval of the Secretary of the Interior.

SEC. 19. That any person violating any of the provisions of this Act, or any rules or regulations made thereunder, shall be guilty of a misdemeanor and shall be punished by a fine of not more than $5,000 or by imprisonment not more than one year, or by both such fine and imprisonment.

SEC. 20. That the Director of the Bureau of Mines is hereby authorized to investigate all explosions and fires which may occur in mines, quarries, factories, warehouses, magazines, houses, cars, boats, conveyances, and all places in which explosives or the ingredients thereof are manufactured, transported, stored, or used, and shall, in his discretion, report his findings, in such manner as he may deem fit, to the proper Federal or State authorities, to the end that if such explosion has been brought about by a willful act the person or persons causing such act may be proceeded against and brought to justice; or, if said explosion has been brought about by accidental means, that precautions may be taken to prevent similar accidents from occurring. In the prosecution of such investigations the employees of the Bureau of Mines are hereby granted the authority to enter the premises where such explosion or fire has occurred, to examine plans, books, and papers, to administer oaths to, and to examine all witnesses and persons concerned, without let or hindrance on the part of the owner, lessee, operator, or agent thereof.

SEC. 21. That the Director of the Bureau of Mines, with the approval of the President, is hereby authorized to utilize such agents, agencies, and all officers of the United States and of the several States, Territories, dependencies, and municipalities thereof, and the District of Columbia, in the execution of this Act, and all agents, agencies, and all officers of the United States and of the several States and Territories, dependencies, and municipalities thereof, and the District of Columbia, shall hereby have full authority for all acts done by them in the execution of this Act when acting by the direction of the Bureau of Mines.

SEC. 22. That for the enforcement of the provisions of this Act, including personal services in the District of Columbia and elsewhere, and including supplies, equipment, expenses of traveling and subsistence, and for the purchase and hire of animal-drawn or motor-propelled passenger-carrying vehicles, and upkeep of same, and for every other expense incident to the enforcement of the provisions of this Act, there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $300,000, or so much thereof as may be necessary: *Provided, That not to* exceed $10,000 shall be expended in the purchase of motor-*propelled passenger*-carrying vehicles.

Approved, October 6, 1917.

Regulations Provided for Control of Explosives.

An act relating to explosives and prescribing regulations for the transportation, storage and selling of explosives, and providing penalties for the violation of this act.

[Approved March 20, 1911.]

The people of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. The term "explosive" or "explosives" whenever used in this act, shall include gunpowder, blasting powder, dynamite, guncotton, nitroglycerine or any compound thereof, fulminate, and every explosive substance having an explosive power equal to or greater than black blasting powder, and any substance intended to be used by exploding or igniting the same to produce a force to propel missiles, or rend apart substances, but does not include said substances, or any of them, in the form of fixed ammunition for small arms. The term "person" whenever used herein shall be held to include corporations as well as natural persons; words used in the singular number to include the plural and the plural the singular. The words "explosive manufacturing plant" shall be understood to include all the land used in connection with the manufacture and storage of explosives thereat.

SEC. 2. Except only at an explosive manufacturing plant, no person shall have, keep or store, at any place within the state, any explosives unless such explosives are completely enclosed and encased in tight metal, wooden or fibre containers, and except while being transported or within the custody of a common carrier pending delivery to consignee, shall be kept and stored in a magazine constructed and operated as hereinafter described, and no person having in his possession or control, any explosives, shall under any circumstances permit or allow any grains or particles thereof to be or remain on the outside or about the containers, in which such explosives are contained.

SEC. 3. (As amended in Chapter 538, Laws of 1917.) Magazines in which explosives may lawfully be stored or kept shall be two classes, as follows:

(*a*) Magazines of the first class shall consist of those containing explosives exceeding one hundred pounds, and shall be constructed wholly of brick, wood covered with iron, or other fireproof material, and must be fireproof, and, except magazines where gunpowder or black blasting powder only is stored must be bullet proof, and shall have no openings except for ventilation and entrance. The doors of such magazine must be fireproof and bullet proof, and at all times kept closed and locked, except when necessarily opened for the purpose of storing or removing explosives therein or therefrom, by persons lawfully entitled to enter the same. Every such magazine shall have sufficient openings for ventilation thereof, which must be screened in such manner as to prevent the entrance of sparks or fire through the same. Upon each side of such magazine there shall at all times be kept conspicuously posted a sign, with the words, "magazine," "explosives," "dangerous," legibly printed thereon in letters not less than six inches high. No matches, fire or lighting device of any kind except electric light shall at any time be permitted in any such magazine. No package of explosives shall at any time be opened in any magazine. No blasting caps, or other detonating or fulminating caps, or detonators, or electric fuzees, shall be kept or stored in any magazine in which explosives are kept or stored, but such caps, detonators or fuzees may be kept or stored in a magazine constructed as above provided which must be located at least one hundred feet from any magazine in which explosives are kept or stored. Magazines in which explosives are kept or stored must be detached and must be located at least one hundred feet from any other structure.

(*b*) On and after January 1, 1919, the quantity of explosives that may be lawfully had, kept or stored in any magazine shall depend upon the distance that such magazine is situated from buildings, highways, or railroads, and upon the protection afforded by natural or efficient artificial barricades to such buildings, highways or railroads. Whenever any of the quantities given in column one of the quantity and distance table hereinafter set forth is had, kept or stored in any magazine in this state, the distance that any quantity given in column one of said table may be lawfully had, kept or stored from buildings is the distance set opposite said quantity in column two of said table, and the distance that any quantity in column one of said table, may be lawfully had, kept or stored from railroads is the distance set opposite said quantity in column three of said table, and the distance that any

quantity given in column one of said table may be lawfully had, kept or stored from highways is the distance set opposite said quantity in column four of said table. The quantity and distance table governing the keeping or storing of explosives is as follows:

QUANTITY AND DISTANCE TABLE.

Column 1 Quantity that may be lawfully kept or stored from nearest building, highway or railroad				Column 2	Column 3	Column 4
Blasting caps		Other explosives		Distance from nearest building, feet	Distance from nearest railroad, feet	Distance from nearest highway, feet
Number over	Number not over	Pounds over	Pounds not over			
1,000	5,000	----------	----------	80	20	10
5,000	10,000	----------	----------	60	40	20
10,000	20,000	----------	----------	120	70	35
20,000	25,000	----------	50	145	90	45
25,000	50,000	50	100	240	140	70
50,000	100,000	100	200	360	220	110
100,000	150,000	200	300	520	310	150
150,000	200,000	300	400	640	380	190
200,000	250,000	400	500	720	430	220
250,000	300,000	500	600	800	480	240
300,000	350,000	600	700	860	520	260
350,000	400,000	700	800	920	550	280
400,000	450,000	800	900	980	590	300
450,000	500,000	900	1,000	1,020	610	310
500,000	750,000	1,000	1,500	1,080	640	320
750,000	1,000,000	1,500	2,000	1,200	720	360
1,000,000	1,500,000	2,000	3,000	1,300	780	390
1,500,000	2,000,000	3,000	4,000	1,420	850	420
2,000,000	2,500,000	4,000	5,000	1,500	900	450
		5,000	6,000	1,560	940	470
		6,000	7,000	1,610	970	490
		7,000	8,000	1,660	1,000	500
		8,000	9,000	1,700	1,020	510
		9,000	10,000	1,740	1 040	520
		10,000	20,000	1,780	1,070	530
		20,000	30,000	2,110	1,270	630
		30,000	40,000	2,410	1,450	720
		40,000	50,000	2,680	1,610	800
		50,000	60,000	2,920	1,750	880
		60,000	70,000	3,130	1,880	940
		70,000	80,000	3,310	1,990	1,000
		80,000	90,000	3,460	2,080	1,040
		90,000	100,000	3,580	2,150	1,080
		100,000	200,000	3,800	2,280	1,140
		200,000	300,000	4,310	2,590	1,300

Whenever the building, railroad or highway to be protected is effectually screened from the magazine, where explosives are had, kept or stored, either by natural features of the ground or by an efficient artificial barricade of such height that any straight line drawn from the top or any side wall of the magazine to any part of the building to be protected, will pass through such intervening natural or efficient artificial barricade, and any straight line drawn from the top of any side wall of the magazine to any point twelve feet above the center of the railroad or highway to be protected will pass through such intervening natural or efficient artificial barricade, the applicable distances given in column two, three and four of the quantity and distance table may be reduced one-half.

If at any time the distances from a magazine to a building, highway or railroad be decreased through the construction of a new building, highway or railroad or by any other means, then the amounts of explosives which may be lawfully had, kept or stored in said magazine must be reduced to correspond with the quantity and distance table.

The term "building" when used in the foregoing table shall be held to mean and include only any building regularly occupied in whole or in part as a habitation for human beings, and any store, church, schoolhouse, railway station or other public place of assembly.

The term "highway" when used in the foregoing table shall be held to mean public streets or public road, and shall not include roads constructed and maintained by private persons.

The term "railroad" when used in the foregoing table shall be held to mean and include any steam, electric or other railroad that carries passengers or articles of commerce for hire.

The term "efficient artificial barricade" when used in the foregoing shall be held to mean an artificial mound or properly revetted wall of earth of a thickness of not less than three feet. The provisions of this subsection (*b*) shall not apply to mining or quarrying operations. Nothing contained in this subsection (*b*) shall be held to prohibit the keeping or storing of explosives at any explosive manufacturing plant which was actually used in manufacturing explosives prior to the fifteenth day of April, nineteen hundred seventeen.

(*c*) Magazines of the second class shall consist of a stout box, and not more than one hundred pounds of explosives shall at any time be kept or stored therein, and, except when necessarily opened for use by authorized persons, shall at all times be kept securely locked. Upon each such magazine there shall at all times be kept conspicuously posted a sign with the words "magazine," "explosives," "dangerous," legibly printed thereon.

Nothing in this section contained shall be held to prohibit the keeping or storing of explosives in any tunnel, where no person or persons are employed; *provided, always,* that any tunnel so used for the storage of explosives shall have fireproof doors, which must at all times be kept closed and locked, except when necessarily opened for the purpose of storing or removing explosives therein or therefrom, by persons lawfully entitled to enter the same. The door of such tunnel magazine shall at all times have legibly printed thereon the words, "magazine," "explosives," "dangerous."

SEC. 4. Any person violating or failing to comply with any of the provisions of sections two and three of this act, shall be guilty of a misdemeanor, and upon conviction thereof, shall be punished by a fine of not less than twenty-five dollars, and not more than one thousand dollars, or by imprisonment not exceeding six months, or by both such fine and imprisonment.

SEC. 5. It shall be unlawful to transport, carry or convey, any explosives between any places within this state, on any vessel, car or other vehicle of any description, operated by common carrier, which vessel, car or vehicle is carrying passengers for hire; *provided,* that it shall be lawful to transport on any such vessel, car or vehicle, small arms ammunition in any quantity, and such fuses, torpedoes, rockets or other signal devices, as may be essential to promote safety in operation, and properly packed and marked samples for laboratory examination, not exceeding a net weight of one-half pound each, and not exceeding twenty samples at one time, in a single vessel, car or vehicle, but such samples shall not be carried in that part of the vessel, car or vehicle which is intended for the transportation of passengers for hire; *provided, further,* that nothing in this section shall be construed to prevent the transportation of military or naval forces with their accompanying munitions of war on passenger equipment vessels, cars or vehicles; *provided, further,* that the transportation of explosives on any freight train in this state that carries passengers for hire in a car or caboose attached to the rear of such train, shall not be held or construed to violate the provisions of this act.

SEC. 6. The railroad commission of this state is hereby empowered to make, publish and promulgate such regulations as are not in conflict with this act and as in the judgment of said commission may tend to the safe packing, loading, storage and transportation of the explosives defined by section one of this act.

SEC. 7. It shall be unlawful to transport, carry or convey liquid nitroglycerine, fulminate in bulk, in dry condition, or other like explosive between any places within this state, on any vessel, car or vehicle of any description, operated by common carrier in the transportation of passengers, or articles of commerce by land or water.

SEC. 8. Every package containing explosives or other dangerous articles when presented to a common carrier for shipment shall have plainly marked on the outside thereof, the contents thereon, and it shall be unlawful for any person to deliver for transportation to any common carrier engaged in commerce by land or water, or to cause to be delivered or to carry any explosive or other dangerous article, under any false or deceptive marking, description, invoice, shipping order or other declaration, or without informing the agent of such carrier of the true character thereof, at, or before the time of such delivery or carriage is made.

SEC. 9. Any person who wilfully violates or causes to be violated any of the foregoing provisions of sections 5, 6, 7, and 8, of this act, shall be deemed guilty of misdemeanor, and upon conviction thereof, shall be punished for each offense by fine not exceeding two thousand dollars, or by imprisonment not exceeding eighteen months, or by both such fine and imprisonment in the discretion of the court.

SEC. 10. Every person selling, giving away, or delivering explosives within this state, shall keep at all times an accurate journal or book of record, in which must be entered from time to time, as it is made, each and every sale, delivery, gift, or other disposition made by such person in the course of business, or otherwise, of any quantity of such explosive substance. Such journal or record book must show in a legible handwriting, to be entered therein at the time, a complete history of each transaction, stating name and quantity of explosives sold, delivered, given away, or otherwise disposed of; name, place of residence, and business of the purchaser or transferee, name of individual to whom delivered, with his or her address. Such journal or record book must be kept by the person so selling, delivering or otherwise disposing of such explosives, in his or their principal office or place of business, at all times subject to the inspection and examination of the police authorities of the state, county, or municipality where same is situated, on proper demand therefor. In addition to keeping the record above provided, it shall be unlawful for any person to sell, give away, or deliver any explosives within this state, without taking from the person to whom such explosives are sold, given away or delivered within this state, a statement in writing showing the name and the address of the person to whom such explosives are sold, given away or delivered, and the place where and the purpose for which such explosives are intended for use, which statement shall be signed by the person to whom such explosives are sold, given away or delivered, or his agent, and be witnessed by two witnesses, known to the person selling, giving away or delivering such explosives, to be residents of the county where such explosives, as shown by such statement, are intended for use, who shall certify that the person to whom such explosives are to be sold, given away or delivered is personally known to each of said witnesses, and that to the best of his knowledge and belief, the explosives are required by such person for the uses and purposes set forth in the statement, which said statement shall at all times be kept on file in the principal office or place of business of the person so selling, giving away or delivering such explosives, subject to the inspection of the police authorities of the state, county or municipality where the same is situated, on proper demand made therefor; *provided,* that nothing in this section shall be held to apply to the delivery of explosives to any person or carrier for the purpose of being transported from a place within this state to any other place within this state; *and provided, further,* that nothing in this section contained shall apply to interstate commerce.

Every person selling, giving away or delivering any explosives without complying with all the provisions of this section shall be deemed guilty of misdemeanor, and upon conviction shall be fined not less than one hundred dollars, and not more than two thousand dollars, or by imprisonment of not less than six months, or by both such fine and imprisonment in the discretion of the court.

In addition to such imprisonment and as cumulative penalty such persons so offending shall forfeit for each offense, the sum of two hundred and fifty dollars, to be recovered in any court of competent jurisdiction, and the party instituting the action for such forfeiture shall not be entitled to dismiss same, without the consent of the court before which the suit has been instituted; nor shall any judgment recovered be set aside, satisfied or discharged save by order of such court, after full payment into court, and all moneys so collected must be paid to the party bringing suit.

SEC. 11. (Repealed by Chapter 538, Laws of 1917.)

SEC. 12. No person, except a peace officer or a person authorized so to do by the owner thereof, or his agent, shall enter any explosive manufacturing plant, magazine or car containing explosives in this state, and any person violating any of the provisions of this section shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be fined in an amount not exceeding one thousand dollars, or by imprisonment not exceeding three months, or by both such fine and imprisonment.

SEC. 13. No person shall discharge any firearms within five hundred feet of any magazine or of any explosive manufacturing plant, and any person wilfully violating any of the provisions of this section shall be deemed guilty of a misde-

meanor and fined not exceeding one thousand dollars, or by imprisonment not exceeding one year, or by both fine and imprisonment.

SEC. 14. No person shall wilfully carry any explosive on his person within this state in any car, vessel or vehicle that carries passengers for hire, or place or carry any explosive while on board any such car, vessel or vehicle, in any hand baggage, roll or container, or place any explosive in any baggage thereafter checked with any common carrier, and any person violating any of the provisions of this section shall be deemed guilty of a felony and upon conviction thereof shall be punished by imprisonment in the penitentiary not exceeding two years.

SEC. 15. Nothing in this act contained shall prevent the operation of, or modify, alter, set aside or supersede the provisions of any municipal ordinance respecting the delivery, storing and handling of explosives.

SEC. 16. Nothing in this act contained shall regulate or apply to any shipment of explosives from a point within this state, consigned to a point without this state, over a line or lines of one or more common carriers.

LIST OF SKETCHES OF SAFETY DEVICES.

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California mine operators. In asking for any of the drawings, they may be referred to by number.

No.
1—Arm and Leg Splints.
2—Electric Pull Switch for Mine Bell Signal.
3—Safety Hook for Bucket.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
7—Details of Safety Clutch for Cage.
8—Detail Sketch of Safety Catch for Cage.
9—Safety Catch for Cage.
10—Miscellaneous Parts of Cage.
11—Shaft Cover for Sinking.
12—Safety Crosshead for Bucket.
13—Iron Drill Rack.
14—Lock Hook for Bucket.
15—Grid Iron for Protection at Collar of Ore Chute.
16—Iron Door.
17—Alarm Bell for Cage.
18—Standard Shaft Gate (Swing).
20—Removable Bonnet for Skip.
21—Cover for Skip.
22—Underground Dry Closet.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
26—Semiautomatic Gate for Mine Shafts.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
31—Gate for Shaft Collar.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
35—Cage Safety Catch Testing Device.
36—Safety Cage for Ladders.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
39—Cabinet and Rack for Mine Rescue Apparatus.
40—Change House.
41—Guard for Rip Saw.
42—Riley Two Deck Cage.
43—Automatic Side Dump Car.
(a) Standard Incline Trip.
(b) Draw Bar.
(c) Lower Hinge of Dumping Mechanism.
(d) Door Catch Angles.
(e) Side View, Side Dump Car.
(f) Details.
(g) Details.
(h) Details.
(i) Details.
(j) Details.
44—Plans for Change House.
45—Guard for Tram Car.
46—Underground Latrine.
47—Door for Cage.

No.
48—Warning Bell for Skips and Cages.
49—Shaft Gate.
50—Trolley Support Methods.
51—Underground Toilet Car.
52—Sanitary Dry Closet.
53—Candle Holder for Miners.
54—Toboggan Stretcher for Underground Use.
55—Circular Removable Bonnet for Skips.
56—Toilet Can for Use in Mines.
57—Drinking Water Keg for Use in Mines.
58—Sanitary Mouthpiece for Drinking Water Kegs.
59—Sanitary Toilet for Use in Mines.
60—Signal Bell for Railroad Crossing.
61—Change House at Mammoth Mine A–D.
62—A Guard to Prevent Releasing the Clutch on a Winding Drum Without First Applying the Emergency Brake.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

LIST OF CLIPPINGS.

Air Compressor Cooling with Water Barrels (Illus.).
A Safe Electric Firing Switch.
Ventilating Blowers.
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Drifting with a Stoper (Illus.).
Improved Safety Door for Dumps (Illus.).
Bucket-Dumping Device (Illus.).
A Suspended Car Dump for Tailings.
A Safety Trolley Wire Box.
Device to Aid in Fuse Spitting (Illus.).
Spitting Fuses.
Lacing Method of Making Primers.
Proper Way to Spit Fuses (Illus.).
Some Safety-fuse Pointers.
Clip for Detonator.
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Homemade Thawing Kettle.
Burning Empty Dynamite Cases.
Sand Filling.
A Fire-Bucket Float (Illus.).
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
Electric Hoists for the Michigan Iron Country.
Automatic Landing Chairs (Illus.).
Spillage and Sinking Pocket (Illus.).
Crossheads for Bucket Hoisting (Illus.).
Skip with Cable Guides.
Runaway Tubs or Hutches (Illus.). A safety hook for shafts of slight inclination.
How to Splice Wire Rope (Illus.).
Socketing Wire Rope.
Miners' Dwellings (Illus.).
Concrete-block Mine Houses (Short).
A Simple Chain Ladder (Short).
Wood versus Steel Mine Ladders (Illus.).
A Ladder for Wet Raises.
Capital Mine Steel Ladders (Illus.).
Steel and Wood Ladder.
A Simple, Strong Chute (Illus.).
A Substantial Ore Chute (Illus.).
Types of Chutes and Chute Gates (Illus.).
Protection of Pipe Lines Against Alkali.
Removable Chute Spray (Illus.).
Allaying Dust on Tailings Dumps.
Drinking Fountain for a Mine (Illus.).
Water Disinfecting Outfit for Field Use (Illus.).
Septic Tank for Underground Latrine (Illus.).
Underground Latrines for Mines (Illus. Description).
Four-deck Shaft-repair Cage (Illus.).
Cover for Shaft Ladderway (Illus.).
Simple Folding Shaft Gate (Illus.).
Hinge for Shaft Doors (Illus.).
Sliding Chain Gates on a Cage.
Safety by an Automatic Shaft Gate.
Simple Shaft Gate at Junction Mine, Warren, Ariz.
Shaft Timbering and Headgear on the Mesabi Range (Illus.).
Light Shaft Timbering (Illus.).
Locked Signal System (Illus.).

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BULLETIN No. 9

SAFETY FUSE

Its Use and Abuse in Mines, Quarries and Tunnels

NOVEMBER, 1918

Issued by the
Industrial Accident Commission
of the
State of California

In Co-operation with
United States Bureau of Mines
and
Coast Manufacturing and Supply Company

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SAN FRANCISCO, CAL.

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO
1918

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA

IN CO-OPERATION WITH

UNITED STATES BUREAU OF MINES

AND

COAST MANUFACTURING AND SUPPLY COMPANY

BULLETIN No. 9.

THE USE AND ABUSE OF SAFETY FUSE IN MINES, QUARRIES AND TUNNELS.

By GRANT H. TOD, of Coast Manufacturing and Supply Company.

INTRODUCTION.

At the earnest solicitation of Chief Mine Inspector Wolflin, Grant H. Tod of the Coast Manufacturing and Supply Company compiled the following interesting and valuable treatise on the use and abuse of safety fuse. Mr. Tod read this paper before the mine inspectors of the Industral Accident Commission, on September 6, 1918.

Mr. Tod, as field engineer for the Coast Manufacturing and Supply Company, has visited every mining district in the western United States and Canada. In the past eight years he has investigated thousands of operations requiring safety fuse and is thus exceptionally well qualified to present his subject.

The Commission considers itself fortunate in having been permitted to avail itself of Mr. Tod's expert testimony and wishes to express its appreciation.

All users of fuse are invited to discuss Mr. Tod's treatise.

The Use and Abuse of Safety Fuse in Mines, Quarries and Tunnels.

By GRANT H. TOD, of Coast Manufacturing and Supply Company.

Definition of Safety Fuse.

The only legal definition known of the term safety fuse is the one contained in the British Explosives Act of 1876; it reads: "Safety fuse means a fuse for blasting that burns and does not explode, which does not contain its own means of ignition, and which is of such strength and construction and contains an explosive in such quantities that the burning of the fuse will not communicate laterally with other fuse."

Any definition of the term safety fuse, other than the above, has no foundation and the so-called guarantees regarding its performance exist only in the mind of the person quoting them.

A fuse manufacturer does not guarantee one single factor of its performance in use, for the reason that he can not control the actions of the persons purchasing, storing and using it, nor can he guard against the many forms of abuse to which it is submitted, from the time it leaves the factory until used.

Choice of Fuse.

It is important that attention be directed to some underground conditions that should be taken into consideration particularly by inspectors when making recommendations regarding types of fuse best suited for the work under consideration.

You should, where possible, be fully informed regarding the following matters:

Are water-drills in use?
Is acid water present?
Is ventilation of the workings natural or artificial?

Where water-drills are in use, the employment of a tape covered fuse is recommended; the grade depending on th

temperature and the amount of water and the nature of the ground being drilled.

When acid is present in sufficient quantities to make it necessary to line the mine pumps with bronze, the use of a fuse of the triple-tape type should be recommended. It has been clearly demonstrated that the lighter forms of jacketing do not meet this severe condition satisfactorily.

In a poorly ventilated mine the use of a white cotton-countered fuse should be discouraged, for the reason that this type of fuse is more easily penetrated by the moisture precipitated by slow moving air currents than is the black-finished type.

Burning Rate Influenced by Transportation and Storage.

Fuse in transit may be easily spoiled by being allowed to come in contact with moisture, or with oily or greasy substances, or by being exposed to the direct rays of the sun for any considerable period of time.

Inspectors when visiting their territories should, where they see carelessness displayed, caution superintendents or foremen that fuse which has had oil, gasoline or distillate spilled on it, or that has been carted to the mine during wet weather without being protected, is very apt to cause misfires.

Proper storage of safety fuse is a vital factor. On every case is found the caution, KEEP COOL AND DRY. It is absolutely imperative that this caution be followed to the letter. Fuse that is stored underground is never in prime condition.

Fuse should never be stored near a boiler, furnace, hot steam pipe or lighted stove. Exposure to heat for only short periods of time is sufficient to cause misfires, to retard the rate of burning and to greatly increase the liability to cause hold-backs. Fuse that becomes overheated to such a degree that it is absolutely spoiled is harmless, but fuse that has been overheated only to such a point that the powder train has become partly saturated with the materials that were originally put on as a water-resisting covering is extremely liable to cause serious trouble owing to its irregular burning.

Fuse stored in temperatures ranging from 45° to 75° F., in buildings that are dry, will remain in good condition for a considerable period of time. It is, however, always well to confine this time period to a matter of months.

A simple test for moisture in a storehouse where a hygrometer is not available is this: Place a salt cellar containing table salt in the building for, say, seventy-two hours. If, at the end of that time, the salt can easily be shaken out of the cellar, the building is suitable as a storage place. Sometimes lack of surface buildings forces temporary storage of fuse, in its original cases, underground. The underground storage place should be well ventilated, cool, and suitable for storage of hay or grain. Any drift or tunnel that will allow hay or grain to become mouldy is absolutely unfitted for storage of any explosive.

Storage of fuse in a damp place retards its burning speed. Even if precautions are taken to attempt to redry the fuse before using, it will be found that the fuse has slowed down from original burning time and is irregular. This irregularity tends to increase the liability of misfires.

It should be remembered that fuse waterproofing is quite as effective in keeping dampness in as it is in keeping external water out and for this reason thorough drying of fuse that has once been wet is indeed difficult.

Experiments have proven that fuse that has been stored in a very damp place varies in burning speed from 17 to 45 per cent from normal.

Exposures to comparatively high or low temperatures for long periods of time retard the burning speed. Cotton covered types of fuse do not suffer as marked changes in this matter as do the tape-covered types. Fuse warmed near a stove showed variation in burning time up to 28 per cent.

While considering the matter of uneven burning time of fuse, it should be remembered that poor storage and the placing of the fuse under uneven stemming* and powder loads, in the same round of holes, are responsible for the majority of complaints that come up for consideration.

Main Causes of Misfires.

Misfires may, for the sake of reference, be placed in three subdivisions: 1. Preventable, 2. nonpreventable, and 3. misfires due to mishandling which extreme care in manufacture can not guard against.

*Tamping.

Preventable misfires are caused by:

Improper capping.
Sharp tamping material.
Wet fuse ends.
Poor storage.
The use of oil, light grease or turpentine-varnish as a waterproofing material.
Nonlighting of all fuse in a round.
Using for primers fuse that has been crushed or walked on.
Improper spacing of holes.

Nonpreventable misfires are caused by:

Defective fuse.
Destruction of fuse by water pressure caused by firing holes in dense ground filled with water.

Misfires due to mishandling are often the result of:

Cutting fuse with a dull instrument.
Cutting fuse at a slant.
Using a narrow jawed, ring cutting crimper.
The nonseating of fuse against the cap composition.
Using fuse for a sling or belt before attempting to use it for its normal function.
Placing a foreign substance between the ends of the fuse and the cap composition.
The use of oil, grease, gasoline, distillate or a paint containing turpentine or linseed oil, in the mistaken idea that it will exclude water from the fuse.

Additional Causes of Misfires.

Certain causes of misfires have been overlooked by the underground staffs of the properties registering complaints. Such causes have been brought to the attention of my company for explanation, and include the following:

1. Fuse powder had been knocked from the end of the fuse by the use of a wire brush, in a misguided attempt to clean the end of the fuse before it was inserted in the cap.

2. Axle grease had been smeared on the entire fifty foot length of the fuse before it was cut into the desired lengths for blasting.

3. A mixture of black powder and guncotton that had been allowed to become wet was placed in the caps before the fuse was inserted.

4. Fuse had been placed in a warm room for several days before it was used, after being capped and dipped, in some cases in light grease and in others in cable dressing.

5. Fuse had been capped and hung submerged in a barrel of oil several hours before using.

6. Fuse had been allowed to hang on nails, underground, for days and even weeks before use.

7. Fuse was cut, capped, and then piled on the floor of the drift for weeks before an attempt was made to use it.

8. Large quantities of fuse were hung on nails, for long periods of time, before use. This caused a fracture of the powder train.

9. Primers were placed over the crossbar of the cage and jerked down sharply to hold them on the bar while being lowered into the mine; the jerking was sufficient to fracture the powder train of the type of fuse in use.

10. Defective caps; these caps had been spoiled on the properties by exposure to steam and moisture.

Another cause of misfires, not as generally recognized as it should be, is the sweep of the air returning to place during blasting operations. This feature is most noticeable in development work, and particularly in massive ground. The displaced air returning to place causes several things to happen. The most common is the throwing of powder out of untamped holes; another, in wet holes, is the driving of the water with great force into the powder cartridges. This at times will so completely fill the powder with water as to cause an imperfect shot. Still another is the destruction of the fuse in the hole that is wet through saturation.

Uneven Burning.

A common cause for this complaint is that a mining company often allows a warehouseman to pile an incoming shipment of fuse in front of the shipment already in stock. Where this is done trouble results for the reason that with age fuse slows down in burning speed. An attempt to use fuse that has been stored, for months, in a warehouse in combination with a fresh shipment has been known to spoil many a round of holes.

Methods and materials used in stemming cause variations in burning time as high as 80 per cent.

The normal speed on the Pacific coast is 40 seconds per foot, when the fuse is burned in the open at sea level.

Investigation of reports of uneven burning time in development work brought to light a curious circumstance: In a majority of the cases investigated it was discovered that the holes that were reported to have gone out of their turn, and thus spoiled the round, were the lifters.

Questioning of the miners who had loaded and fired such rounds showed that they all believed that "the fuses in the lifters had to stand the jar and vibration of all the other holes in the same round and for that reason should be located as deeply and tamped as securely as possible." Following that line of argument, the miner loaded the primer in the point (bottom) of the lifter and also tamped it. The lifters were usually the only holes in the round that were at all carefully tamped and the location of the primer in any one of the other holes was largely problematical, usually at some point in the hole that suited the fancy of the particular miner loading the hole. The result of this method of loading was that the lifter would fire out of rotation and spoil the round. The speed of the fuse in the lifters was governed by the pressure exerted on it for considerable length by the explosive load and the stemming. This caused very rapid burning.

Although the company with which I am connected does not attempt to settle the much mooted question of the most desirable location of a primer in a hole, it does insist that, if good results are expected from safety fuse in regard to even burning, the primers in all the holes in the same round should be subjected to about the same pressure on relatively equal lengths.

Another cause for uneven burning for which the fuse is in no way to blame is the improper spacing of holes. This practice often causes holes to fire out of rotation, owing to ground squeeze created by firing holes drilled too closely together.

If a mine inspector receives complaints that lifters are missing in wet ground, he should carefully determine whether too close spacing of holes, instead of defective fuse, is not responsible for the trouble. Where the holes immediately above the lifters are drilled too close to them, their bursting causes the water in the lifters to drive laterally through the fuse, in many cases destroying it. This trouble can easily be remedied in

wet and damp ground by putting a reasonable burden on the lifters.

Elimination of Misfires.

Having stated the causes of many misfires, let us start from the assumption that the fuse has been properly made and stored and see what can be done to eliminate much of the trouble.

Consider first the making up of the fuse into a primer. (The term primer for the purpose of this paper may be considered to be a capped fuse.)

The first operation is cutting of the fuse with some sharp instrument, square across. Never fail to cut off a fraction of an inch from the end of a fuse that has been exposed to the air for any length of time and never cut a fuse on a slant, as this may cause the sharp point formed by this form of cut to double over in the cap barrel. This would cause the fire from the fuse to hit the side of the cap instead of reaching the cap composition.

Next, care must always be taken to press the end of the fuse lightly against the cap composition before crimping. This precaution must be used so that no air space is left between the end of the fuse and the cap composition. A large percentage of misfires in mining is caused by not following this simple but vital practice.

For the benefit of many persons who do not know the reason for the necessity of observing great care in this matter, the following explanation is offered, together with a simple demonstration to prove the contention.

Burning fuse generates about one and one-quarter liters of gas for each foot, and this gas is known, by analysis, to contain, roughly, 23 per cent carbon monoxide and 33 per cent carbon dioxide. An indefinite volume of the gases generated by the burning fuse precedes the fire in the fuse, through the powder train. The distance is governed largely by the jacket of the fuse and the condition under which the fuse is used. When fuse is burned in dry ground, unstemmed, the gas precedes the fire by only a short distance, but when burned in a wet hole where the water keeps the fuse jacket cool and holds down the side spit, the gas generated by the burning fuse is forced ahead of the fire, in many instances, as far as 24 inches.

It can readily be seen that under these conditions, if an air space is left in the cap-barrel, and the cap is crimped tightly enough to retain the fire extinguishing gases in the unoccupied space, the spit from the enclosed fuse-end will not shoot forward with its usual heat and energy, but will simply bubble feebly and does not come in contact with the cap composition with sufficient heat to fire it.

A simple way to demonstrate this matter of gas preceding fire in a fuse is to take a basin of clear water, submerge two feet of a three foot piece of fuse, and light the dry end. Before the fire in the fuse reaches the water level, gas will be observed coming from the submerged end. By the time the fire reaches a point about nine inches from this end, the flow of gas will have become continuous and relatively large in volume.

For crimping a cap to the fuse, only a broad-jawed crimper should be used. This type of tool seldom cuts a cap shell.

In cold weather fuse should be warmed slightly before uncoiling is attempted.

In outside work fuse should be protected from dampness and the direct rays of the sun when circumstances force its being exposed to the weather for any length of time.

When fuse is to be used in wet work it is well to seal the joint of cap and fuse with a suitable preparation. For this purpose P B roofing paint, having an asphaltum base, pine tar, and Celakap are recommended as the most suitable.

Erroneous Theories.

I now take up some beliefs that time and constant repetition have caused to be accepted but that are erroneous.

The exterior appearance of a fuse is often taken as a reliable indication of its quality. However, fuse of dingy appearance is often excellent in quality.

Some grades of fuse waterproofing will absorb the white material put on the outside, causing the fuse to become a dirty yellow color. This in no way affects the burning quality of the fuse. A test would easily determine the quality of the fuse and avoid unnecessary complaints. Contrary to popular belief, the center thread is not chemically treated to assist in the burning quality of the fuse. The absence of the center

thread will not alter the burning speed of the fuse; its function is merely to make a more certain flow of powder in the fuse-making machine.

It should be recollected that safety fuse is not intended to be tied into knots nor is it designed to withstand other unnecessarily rough or careless treatment. If carefully handled, it is expected to serve as a reliable means of conveying fire to the charge.

In only rare instances will safety fuse fail to perform its function, if common sense is exercised in its use.

Conclusion.

The chief reason for preparing this paper is to cause mine inspectors and the mining fraternity in general to discuss and criticise it, as only in this way will be determined all the causes of a very dangerous and expensive feature of mining, namely, misfires.

It is customary for some persons to blame safety fuse for the majority of misfires, without endeavoring to discover the reasons why fuse does not perform its function.

My paper will have attained its purpose if it encourages the investigation of the causes of misfires and thus makes for their elimination.

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BULLETIN No. 10

RELATING TO

Safeguards Against Injury in Quarries

January 1, 1919

Issued by the
Industrial Accident Commission
of the
State of California
in co-operation with
United States Bureau of Mines

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1918

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INDUSTRIAL ACCIDENT COMMISSION OF THE STATE OF CALIFORNIA
In Co-operation with
UNITED STATES BUREAU OF MINES.

BULLETIN No. 10.

SAFEGUARDS AGAINST INJURY IN QUARRIES.

By G. CHESTER BROWN, Deputy Mine Inspector.

FOREWORD.

Quarry Safety Rules have been compiled by a committee of quarry operators and representatives of quarry employees, in collaboration with the Mining Department of the Commission. These rules become effective January 1, 1919.

It is the policy of the Industrial Accident Commission to publish bulletins, from time to time, on methods of preventing injuries to employees. Herein are examples of adequate and inadequate protection, illustrated by photographs taken in the field during inspection trips.

As an introduction to the succeeding pages of this bulletin, there are submitted a few statistics on the number of fatal, permanent and temporary injuries and the compensation and medical expense entailed for the year 1916, and also the number of fatal, permanent and temporary injuries for the year 1917.

In quarrying, as well as in metal mining, during the year 1916, the greatest number of injuries were caused by falling, rolling or flying objects, such as rock, steel, timbers and tools; dangerous substances[1] caused the next greatest number of injuries.

[1]Such substances as electrical equipment, explosives and hot metal, or any other similar substance that is dangerous to handle.

Quarry Injuries in California During the Years 1916 and 1917.

During the year 1916 there were 1,287 industrial injuries reported by operators of quarries.

By degree of injury they were as follows:

Fatal	20
Permanent	38
Temporary	1,229
Total	1,287

The chief causes of the injuries occurring in the quarries of the state were as follows:

	Number temporary	Number permanent	Cases fatal	Days time lost in temporary cases	Award in permanent and fatals	Compensation paid, all cases	Medical aid paid, all cases
Machinery	77	9	-------	782	$7,335 60	$3,686 80	$301 00
Dangerous substances	206	5	4	1,132	9,454 10	3,672 06	1,516 10
Falling, rolling or flying objects	473	19	8	4,005	14,105 09	10,849 62	5,475 80
Personal falls	139	-------	1	2,023	1,760 00	1,789 00	1,230 50
Animals	8	-------	-------	117	----------	50 00	58 00
Collisions or derailments	151	3	3	1,770	6,184 14	2,482 46	1,795 45
Tools	84	2	-------	744	16 60	627 41	464 00
Miscellaneous	79	-------	4	810	1,350 00	1,666 28	1,023 00
Unknown	12	-------	-------	79	----------	34 00	149 00
Totals	1,229	38	20	11,462	$40,205 53	$24,857 63	$12,512 85

For the year 1917 there were 1,140 industrial injuries reported by operators of quarries.

By degree of injury they were as follows:

Fatal	10
Permanent	39
Temporary	1,091
Total	1,140

Causes of fatal injuries were as follows:

Machinery	1
Dangerous substances	2
Falling, rolling or flying objects	6
Collisions or derailments	1

Dangerous work in a glory hole where there is no bench. Note the hand rope lying on the slope. The man is working so far from the rope that if a slide started he would probably not be able to reach the rope.

ACKNOWLEDGMENT.

For helpful suggestions in the preparation of this bulletin, acknowledgment is due to the publications listed below, viz:

Technical Paper 111.—Safety in Stone Quarrying, by Oliver Bowles, issued by U. S. Bureau of Mines.

Bulletin 124.—Sandstone Quarrying in the United States, by Oliver Bowles, issued by U. S. Bureau of Mines.

Miners Circular 11.—Accidents from Mine Cars and Locomotives, by L. M. Jones, issued by U. S. Bureau of Mines.

Technical Paper 18.—Magazines and Thaw Houses for Explosives, issued by U. S. Bureau of Mines.

Bulletin 80.—A Primer on Explosives for Metal Miners and Quarrymen, issued by U. S. Bureau of Mines.

The Travelers Standard.—Quarry Hazards, issued by The Travelers Insurance Company and The Travelers Indemnity Company.

FALLING, ROLLING OR FLYING OBJECTS.

Statistics indicate that falling, rolling or flying objects are responsible for the greatest percentage of injuries in quarries. It is therefore necessary to pay more than casual attention to proper methods for removing the danger of falls of overburden or of rocks into the quarry pit. Constant watch must be kept and at frequent intervals tests for scale and loose rock should be made. The walls as well as the roofs of quarry tunnels should be inspected and tested, and also the walls in undercut or open workings.

One means of preventing such dangers is to make the overburden walls less steep and to strip some distance ahead of quarry operations, leaving the stripped surface to collect the falling material.

Dangerous hand work along narrow bench where material is shoveled directly into a chute.

The greatest dangers from rock slides at the faces are in quarries where rock is produced for crushing purposes. The quarry faces are shattered and thrown down by explosives, and remain in a very unsafe condition, unless adequate precautions are taken.

Injuries from rock slides may be avoided by having a crew of reliable men roll down loose rock after all quarry work has stopped at the end of the day-shift. Every fragment that appears to be in danger of ro[illegible] should be sent to the bottom of the quarry. If, during [illegible] loose rock is observed it should be removed immediately. [illegible] quarry face is high and precipitous, workmen should be [illegible] *the top* by means of ropes so that they may bar down

e fragments. While it is advisable to have watchmen at quarries 'arn employees when loose rocks are about to fall, too much depend- e should not be placed on the watchmen for men are apt to be injured le endeavoring to seek a place of safety, after being warned. hough watchfulness and good supervision may reduce the risks of ıries from material falling from a high face, it is advisable to ease the number of benches when the faces are very high. Many rries are worked by means of low benches, from 20 to 30 feet high, rder to eliminate the menace of falling rocks from high and precip- s faces.

Foreman supervising the barring down of loose rock.

ıspection at the face of the quarry is required by the Quarry Safety es as listed below:

i) The superintendent of the quarry or a competent man detailed this purpose shall make frequent inspections of the face of the ry where men are employed and shall dislodge any slabs of rock aid face that may be dangerous to employees.

) Where necessary, watchmen shall be employed at each face to *the men in the quarry* when loose rocks are about to fall.

(*c*) Where practicable, the face of the quarry shall be given such a slope as to eliminate the danger of rocks falling upon the men employed therein.

Another source of danger to quarrymen is carelessness on the part of employees in throwing down tools or drills so that they roll into the pit. Careful supervision of quarry employees should be maintained by the bosses to the end that tools, etc., may be left in a safe place when not in use by the workmen.

The driving of tunnels, raises, etc., in connection with quarry operations should meet the requirements of the Mine Safety Rules (Sections 30 (*b*), 31, 32, 33, 35). The safety of employees engaged in tunnel

Shelter tunnel for use during blasting.

work depends, for the most part, on careful inspection, the barring down of loose rock and the proper use of timber.

The construction of adequate shelter places for use during blasting is another important thing which should be carefully considered by quarry operators. Employees should be protected from flying fragments and also have overhead protection from small pieces, which may be blown high into the air and fall almost vertically. There is great danger, especially in granite quarries, of men leaving their shelters before fragments that have been projected to a great height reach the ground. The bosses should be certain that all quarry employees are in their shelter places before blasting and should permit none to leave his *shelter until sufficient* time after blasting has elapsed to remove all *danger from flying* fragments. Proper signals for blasting should be *devised, and all* quarrymen should be required to know these signals.

DANGEROUS SUBSTANCES.

Dangerous substances include electrical equipment, explosives and hot metals, or any other similar substance that is dangerous to handle.

The storage and use of explosives should be carefully supervised by the superintendent or a competent man. In fact, the Federal Explosives Law requires such supervision. This law compels manufacturers, vendors, and those who buy or receive explosives to possess a license, to keep complete records of the uses to which explosives are put, and to require the return of unused explosives to the magazine. It requires that magazines be properly constructed and securely locked; for failure

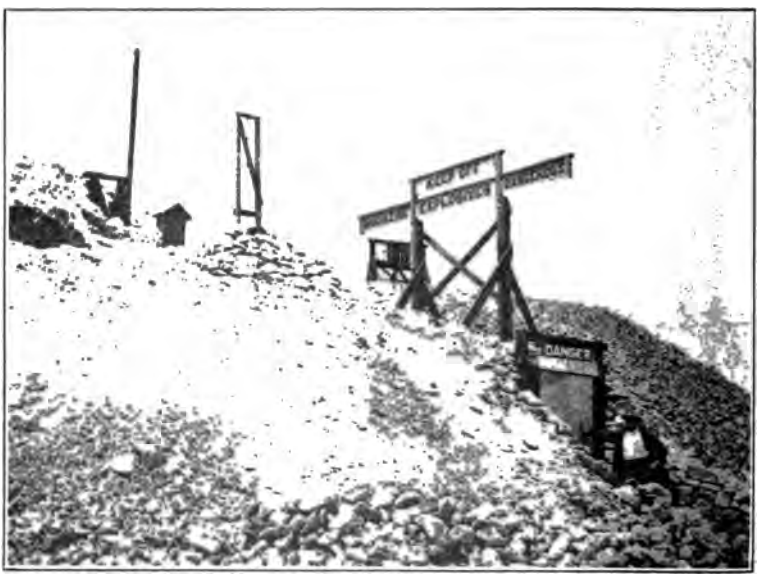
A first-class cement mortar magazine. The words "Keep Off" are lacking, which are required by the Federal Explosive Act. The Federal Explosive Act prohibits the placing of signs on magazines, but requires that the signs be placed on the premises near the magazines. It has been decided that proper signs on bulletproof magazines in existence before the act became effective need not be changed.

to comply with its requirements, the law provides a maximum fine of $5,000 and imprisonment for one year.

Properly constructed magazines for the storage of explosives are of great importance in the safe operation of quarries or of any industry in which explosives are used. Magazines should be bulletproof, fireproof, dry and well ventilated. A cement mortar magazine built in a safe location, and equipped with a heavy iron door, lock and a danger sign, meets the requirements of the law. A barricade of earth, however, should be built around such a magazine, unless it is such a distance from the works as to avoid danger from flying fragments in case of an explosion.

A tunnel driven into solid ground, with offsets in which the explosive is stored, also makes a safe magazine, provided it is dry and well ventilated.

A first-class magazine made by driving a tunnel into solid ground.



A first-class tunnel magazine with a sign that fulfills both federal and state requirements.

Technical Paper 18, "Magazine and Thaw Houses for Explosives," issued by the U. S. Bureau of Mines, contains valuable information regarding the construction of magazines. Requests for this publication should be addressed to the Director, Bureau of Mines, Washington, D. C.

A good second-class magazine. To facilitate operations, one or more of these are necessary at large quarries.

Using paper funnel in loading deep holes with granulated powder.

Bulletin No. 8, "Relating to Safety Requirements for the Storage and Use of Explosives in Mines, Quarries and Tunnels," issued by the Industrial Accident Commission, contains a digest of the Federal Explosives Act.

The history of nearly every quarry will show that at some time during its life, blasting operations have been carried on and that injuries have resulted from the improper use of explosives. In some quarries, notably those from which marble and structural stone are obtained, blasting

Equipment for quarry powder-man shooting block-holes and dobits. Capped fuse is carried in the cylindrical leather case. Sticks of dynamite are carried in the red wooden box, the covers of which are held by brass spring hinges. The brass knife, fastened to the outside of the box is used to slit dynamite cartridges. The blotting paper which lines the box and all tamping sticks are periodically destroyed.

forms an insignificant part of the work, while in most of the other kind of quarries it is of frequent occurrence. It is therefore of great importance to have an experienced and competent man in charge of this work.

The explosives in most common use in quarries are black blasting powder, granulated powder containing a small percentage of nitroglycerin, dynamite containing 15 to 60 per cent nitroglycerin, ammonia dynamite and blasting gelatin. The choice depends mainly upon the work to be done, and upon the nature of the material to be broken.

The requirements for the storage and use of explosives as outlined in the Quarry Safety Rules should be carefully followed.

Where black powder is used, it should be loaded into the holes through a wooden or paper funnel, and care should be taken that none is scattered about as it might cause a premature explosion by boot nails striking fire on the rock surface.

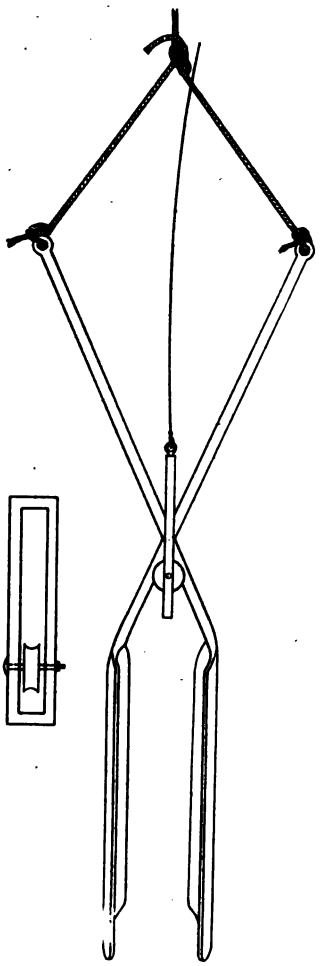
QUARRY ACCIDENT.

This man's hand was blown full of rock when he dropped a stick of powder into a 20-foot hole. The depth of the hole was the only thing that saved his life. The hand will be permanently disabled.

Where deep-hole blasting is employed, injuries sometimes result from improper methods of lowering the explosives into the holes. Dropping dynamite sticks into holes many feet deep is a common practice at some quarries, although some other method might result in greater safety. A simple device for lowering dynamite into blast holes is shown on page 20 of Technical Paper 111, "Safety in Stone Quarrying," issued by the U. S. Bureau of Mines.

The description of the device as given in Technical Paper 111 is as follows:

The holder (Fig. 1) consists of a pair of tongs with the blades trowel-shaped to fit the cartridge. A rope which branches in a V to the upper end of each handle holds the jaws shut and prevents the cartridge from falling out. A second cord is employed to release the cartridge. It is attached to the upper end of a bar with a slot, through which passes the intersection of the jaws at their pivot. This slot allows the bar to slide upward when the cord is pulled. At the lower end of the slot is a roller which ascends in the inverted V formed at the pivot and spreads the jaws of the holder, releasing the cartridge. An improvement which might be suggested for this device would be to make it of hard wood rather than of iron. There are two dangers surrounding the use of a metal instrument. First, nitroglycerin may get around the pin where the jaws work against each other and so cause an explosion by friction. Second, lowering of sticks repeatedly into the same hole may result in small bits of dynamite being rubbed off on the walls of the hole or small particles remaining on the jaws of the instrument, and these may be struck between the iron and the rock surface in hauling the device from the hole.



Holder for lowering dynamite into blast holes.

Requests for Technical Paper 111 should be addressed to the Director of the Bureau of Mines, Washington, D. C.

The greatest danger in blasting is from delayed blasts, partly exploded charges and misfires. If a series of holes is shot at one time, the failure of one or more charges to explode may not be observed, and subsequent operations may cause the discharge of the explosive in the missed holes. In the case of incomplete detonation, pieces of dynamite or some unexploded powder may be scattered among rock fragments and thus constitute a grave danger if struck by metal tools.

Blasting within a quarry should be in immediate charge of bosses or shot firers, who should cause warnings to be given in every direction and keep guarded all entrances to the places where charges are to be fired.

When a blast has been fired and it is not certain that all the charges have exploded, no person should enter the place where such charges were placed, within at least one hour after the explosion.

No quarryman should be permitted to extract or attempt to extract explosives from a bore hole that has once been charged, but should, when possible, put in a new primer and blast again. When not possible to do this, a new hole should be drilled, which should not be nearer to the original hole than two feet; and should be pointed at such an angle as to eliminate all danger of its meeting or coming closer to the other hole than two feet, and such new hole should be charged with a fresh charge of explosives and then detonated; when the above can not be complied with, a hole nearer than two feet may be drilled under the direct supervision of the boss.

Electric firing is to be preferred to fuse as the results are instantaneous and there is no waiting in suspense; moreover, there is less danger of delayed explosions.

Bulletin 80, "A Primer on Explosives for Metal Miners and Quarrymen," issued by the U. S. Bureau of Mines, contains the following rules for firing blasts by electricity which should be observed:

Connecting Legs to Leading Wires.

An electric igniter or an electric detonator should be so loaded into a bore hole that while it is in perfect contact with the charge the legs of the igniter or detonator reach at least 6 inches out of the completely stemmed and tamped hole. Both legs should be bared of their insulation for about 2 inches from their ends, and the wires so cleanly scraped that a good electrical contact can be made with them. Each leg is then firmly connected with one of the leading wires by about five turns.

Splices Should Not Be Opposite—Wrapping Splices.

It is bad practice to have the two splices directly opposite each other, because when the leading wires are pulled the splices may touch one another and thus make a short circuit, which will prevent the electric igniter or electric detonator from being exploded. A better plan is to wrap the bare-wire splice with tape made for the purpose, which completely insulates them.

Connecting Leading Wires to Firing Machine.

After the legs are spliced to the leading wires (and not till then), the wires are connected to the firing machine, from which the electric current is to be obtained. This last connection should never be made until all the men are at a safe distance from the place where the blast is to be fired.

All Connections to Be Made From Bore Hole to Firing Machine.

The rule should be made and never broken that when bore holes are charged the "connecting up" shall move from the bore hole back to the firing machine. The work in all blasting operations should be so organized that it can never be possible for the leading wires to be coupled to the firing machine while any one is about the place where the holes are being charged and where the blast is to be fired.

Requests for Bulletin 80 should be addressed to the Director of the Bureau of Mines, Washington, D. C.

The man who loads the holes should fire them and no one else should be allowed to touch the switch or firing machine. Injuries have resulted from misunderstandings and confusion of orders when one man loads and another fires.

When electricity is used to fire shots, no person should be allowed to enter the vicinity of the place where such shots have been fired, until the cable from the source of electrical energy to the face of the blast has been disconnected and short-circuited. It should be the duty of the boss or shot firer to see that all such cables are disconnected immediately after such firing and to examine or direct the examination of such places where the shots have been fired before any men are permitted to work therein.

If fuse is employed, the approximate rate of burning of the fuse should be known and sufficient length allowed to permit escape to a safe distance. An instructive discussion regarding fuse and the making of the primer is to be found on pages 11–12 of Bulletin No. 2, "Relating to Safety and Efficiency in Mines," issued by the Industrial Accident Commission.

Requests for Bulletin No. 2 should be addressed to the Industrial Accident Commission, 525 Market street, San Francisco.

SAFEGUARDS AGAINST INJURIES FROM ELECTRICITY.

Inexperienced persons should not be allowed to work with electricity.

Poles supporting high voltage wires, transformer houses and other dangerous electrical equipment should be amply provided with danger signs. Employees who can not read should be carefully instructed so that they will have an understanding of all danger signs, especially those warning about electricity.

Locks by means of which electric switches may be locked in the open position and the keys to them held by the person who is making repairs will prevent many serious accidents from electric shock and unintentional starting of motors.

Transformers should be placed in enclosures so that no one, except an authorized person, can enter the premises on which they are located.

All underground trolley wires that are within six and one-half (6½) feet of the tops of the rails must be suitably protected. In new installations all wires that are within seven (7) feet of the tops of the rails must be guarded. The wires may be protected by placing boards on each side of them. The boards must extend at least three inches below the wires. The trolley wires should be placed to one side of the tunnel, at least six inches outside of the track, so that the employees are not walking directly beneath them when entering or leaving their working

Looking into tunnel where cars are loaded. Note that the trolley wire is well guarded but that the loading platform lacks a middle rail and a toe-board.

places. Employees should never be allowed to carry tools on their shoulders when walking under or near electric wires.

Instructions for resuscitation of persons suffering from electric shock should be posted near all electrical equipment.

RAILS AND MACHINERY GUARDS.

Guard rails and machinery guards are life savers. At some quarries a woeful lack of guards for belts, machinery, etc., is noticeable. Many injuries that are attributed to lack of care or to chance, may be avoided by the observance of the General Safety Orders issued by the Industrial Accident Commission, which require protection of the moving parts of machinery, belts, etc.

All elevated walks, runways, or platforms, except on loading or unloading sides of platforms, if four (4) feet or more from the floor

level, must be provided with a two-rail railing not less than three and one-half ($3\frac{1}{2}$) feet high. If height exceeds six (6) feet above floor level, a toe-board must be provided to prevent material from rolling or falling off.

Runway below tube mill. No toeboards provided. The two kilns to right have unguarded trunnions.

These large high-speed unguarded belts are serious hazards to employees.

All belts, ropes or chains driving machinery or shafting, and all secondary belts, ropes or chains, where exposed to contact, must be guarded. In all cases the point where the belt, rope or chain runs on to the pulley, sheave or sprocket, if within seven (7) feet of the floor or platform, must be guarded. Exception: Belts which are so small or slow moving that they are not in any way a source of danger.

Guard rails can be constructed of metal or wood, but in all cases the standards must be securely fastened at the bottom.

All gears, pulleys, clutches, shafting, set screws, sprockets, flywheels and grinding wheels must be protected in accordance with the General Safety Orders.

Exposed set screws in shaft collar, blind end of shaft unguarded and exposed gears. Inadequate and unprotected platform.

Risks—Clothing may be caught on set screws, or on blind end of shaft. Clothing or hands may be caught in gears. Misstep may result in fall off platform or into gears.

Remedies—Replace square-headed set screws with hollow set screws, cover blind end of shaft and gears, increase size of platform and provide handrail and steps.

Operators can assist in the preservation of lives and limbs by covering gears, belts, and moving parts of machinery, by placing danger notices in conspicuous places and by careful inspections of all equipment to make certain that parts of machinery are not defective, and that all guards are in place.

Employees who work around revolving shafts, wheels or winding cables, should not wear loose clothing with parts which may become entangled in the machinery.

A safe method of holding cars at the top of a grade.

An unsafe method of "blocking" cars at the top of a grade. Where cars are set out on a track at the top of a grade, some substantial means *of preventing* a runaway should be provided.

HAULAGE INJURIES.

Haulage injuries are caused by quarry cars, or locomotives, and by the breaking of cables, guy wires, derricks, booms, etc. Injuries of this kind, especially those caused by collisions or derailments, can be avoided, to a large extent, by careful supervision of employees and by watchfulness on the part of the men, by systematic inspection of equipment and by immediate repair or replacement of insecure parts.

The frequency of injuries due to rock haulage may be avoided by installing adequate brakes on all the cars, by maintaining the tracks in good condition and by placing proper bumpers or some other device on the track so that cars can not run into quarry excavations.

None but those engaged in transportation duties should be allowed to ride on quarry or railroad cars, unless careful provision is made for the carriage of passengers.

In handling quarry or railroad cars, a brakeman commonly runs along the track ahead of the moving car to throw a switch. This practice should not be allowed under any circumstances. Where switching operations are conducted, a path inside the tracks should be provided and should always be used. Injuries due to men tripping and being run over before they can recover their feet may happen at any time; employers should provide proper runways for the brakemen.

Employees should not be allowed to walk on the quarry tracks, especially if cable cars are controlled from a hoist shed. If the tracks are steeply inclined, the danger is greater.

Prominent danger signs should be placed at necessary places along all car tracks.

Where doors open directly upon car tracks, a device to prevent employees from stepping directly in front of a car, should be provided; a mere danger sign may be overlooked. Two simple swinging gates with a spring attachment to make them close, and with the danger sign attached are adequate.

Where cars are regularly set out on a grade or at the top of a grade, some substantial means of preventing a runaway should be installed. A movable bumper or a derail switch is suggested.

CARE OF THE INJURED.

The Quarry Safety Rules require that first-aid supplies must be kept at all quarries. A stretcher of the type approved by the Industrial Accident Commission, is among the list of first-aid supplies required to be within easy reach at a quarry. The Homestake and the Stokes Navy stretchers have been approved by the Commission.

The Homestake stretcher is especially adapted for the transportation of *an injured man* down raises, or through difficult openings. This

stretcher with canvas, instead of leather, can be purchased for $18 or, on application to the Chief Mine Inspector, specifications for the stretcher will be sent gratis, and it can be made at the plant.

The Stokes Navy stretcher, which can be purchased for $36, is also approved for quarry work. It is constructed of wire mesh and fits the form of the patient and contains straps for binding the patient in place.

First-aid training is required at all quarries, and it will be the duty of the operator or superintendent to provide, not less than once in each calendar month, for instruction of the employees in the proper handling and treatment of injured persons before the arrival of a physician. Such instructions may be given by a physician or by any competent first-aid instructor. The rules provide that at all quarries, at least 5 per cent of the employees shall receive thorough first-aid training, and that not less than three men at each quarry shall be qualified to administer first-aid to the injured.

Mr. Walter F. Pyne, formerly of the U. S. Bureau of Mines, has been engaged by the Industrial Accident Commission as a first-aid instructor. He will be continually employed among the quarries, mines and gold dredges in training men in first-aid. First-aid is not only of great importance in case of injuries to employees, but the training tends to make the men more careful.

SANITATION, BATH FACILITIES, DRINKING WATER.

The sanitary conditions at a quarry should receive careful attention, for the health of employees is not only a safety measure, but tends for efficiency. A sanitary camp means an increase in the willingness and efficieney of the labor.

The state legislature in 1913 enacted a law regulating the sanitation at camps where five or more persons are employed, and placed the enforcement of the act under the jurisdiction of the Commission of Immigration and Housing.

A publication issued by the Commission of Immigration and Housing, "Advisory Pamphlet on Camp Sanitation and Housing," should be carefully read by quarry operators, for it contains much valuable information.

Requests for this publication should be addressed to the Commission of Immigration and Housing, 525 Market street, San Francisco.

An adequate change house should be provided at a place convenient to the quarry, for the purpose of drying the clothing of the persons employed in and about the quarry. Such a change house should be equipped with shower baths with hot and cold water, at least one shower being provided for each 15 men on a shift; it should be provided with

adequate means of heating and lighting and should be available to the men at all times.

An act of the state legislature which went into effect August 8, 1915, makes it compulsory for every employer of labor in this state to provide fresh and pure drinking water to his employees during working hours. Access to such drinking water must be permitted at reasonable and convenient times and places.

LIST OF SKETCHES OF SAFETY DEVICES.

There is submitted below a list of drawings of safety and efficiency devices, which may be secured free of cost by California quarry operators. In asking for any of the drawings, they may be referred to by number.

No.
1—Arm and Leg Splints.
4—Continuous Ringing Bell for Motors.
5—Safety Elevator Gate.
6—Automatic Switch to Operate Colored Signal Lights.
13—Iron Drill Rack.
15—Grid Iron for Protection at Collar of Ore Chute.
23—Guard for Underground Trolley Wires.
24—Shaft Gate.
25—Metal Stretcher.
27—Underground Stretcher—Homestake.
28—Belt Shifter on Lathe.
29—Sheet Iron Covers for Locking Boiler Valves.
30—Water Gauge Glass Guards.
32—Protective Railings for Boilers.
33—Grinding-wheel Guard.
34—Emery Wheel Eye Shield.
37—Tipple for Dumping Mine Cars.
38—Stretcher Drill Diagram.
40—Change House.
41—Guard for Rip Saw.
43—Automatic Side Dump Car.

(a) Standard Incline Trip.
(b) Draw Bar.
(c) Lower Hinge of Dumping Mechanism.
(d) Door Catch Angles.
(e) Side View, Side Dump Car.
(f) Details.
(g) Details.
(h) Details.
(i) Details.
(j) Details.

44—Plans for Change House.
45—Guard for Tram Car.
50—Trolley Support Methods.
54—Toboggan Stretcher for Underground Use.
58—Sanitary Mouthpiece for Drinking Water Kegs.
60—Signal Bell for Railroad Crossing.

In addition to the drawings listed above, there are set forth below the titles of a limited number of clippings that are on hand. These are made up chiefly of sketches and descriptive text. They will be mailed on request, free of cost, as long as they last.

LIST OF CLIPPINGS.

Air Compressor Cooling with Water Barrels. (Illus.).
A Safe Electric Firing Switch.
Ventilating Blowers.
Aurora's (Nev.) Change House (Illustrated with cost estimate).
Improved Safety Door for Dumps (Illus.).
A Safety Trolley Wire Box.
Device to Aid in Fuse Spitting (Illus.).
Spitting Fuses.
Lacing Method of Making Primers.
Proper Way to Spit Fuses (Illus.).
Some Safety-fuse Pointers.
Clip for Detonator.
Bag for Carrying Dynamite (Illus.).
A Simple Dynamite Thawer (Illus.).
Homemade Thawing Kettle.
Burning Empty Dynamite Cases.
Coupling Hook for Mine Motors (Illus.).
Finger Guard on Tram Car (Illus.).
Safety Hand Grip for Mine Car (Illus.).
How to Splice Wire Rope (Illus.).
Socketing Wire Rope.
A Ladder for Wet Raises.
Capital Mine Steel Ladders (Illus.).
Steel and Wood Ladder.
A Simple, Strong Chute (Illus.).
Types of Chutes and Chute Gates (Illus.).
Removable Chute Spray (Illus.).
Gravity Release Electric Signal Box (Illus.).
Automatic Locomotive Gong.
Raising a Gin Pole (Illus.).
Safety Staging Hook (Illus.).
Emergency Pipe Wrench (Illus.).
Water Tank Indicating Gauge (Illus.).

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BULLETIN No. 11

Petroleum Safety Bulletin

JUNE, 1922

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A NEED AND THE REMEDY.

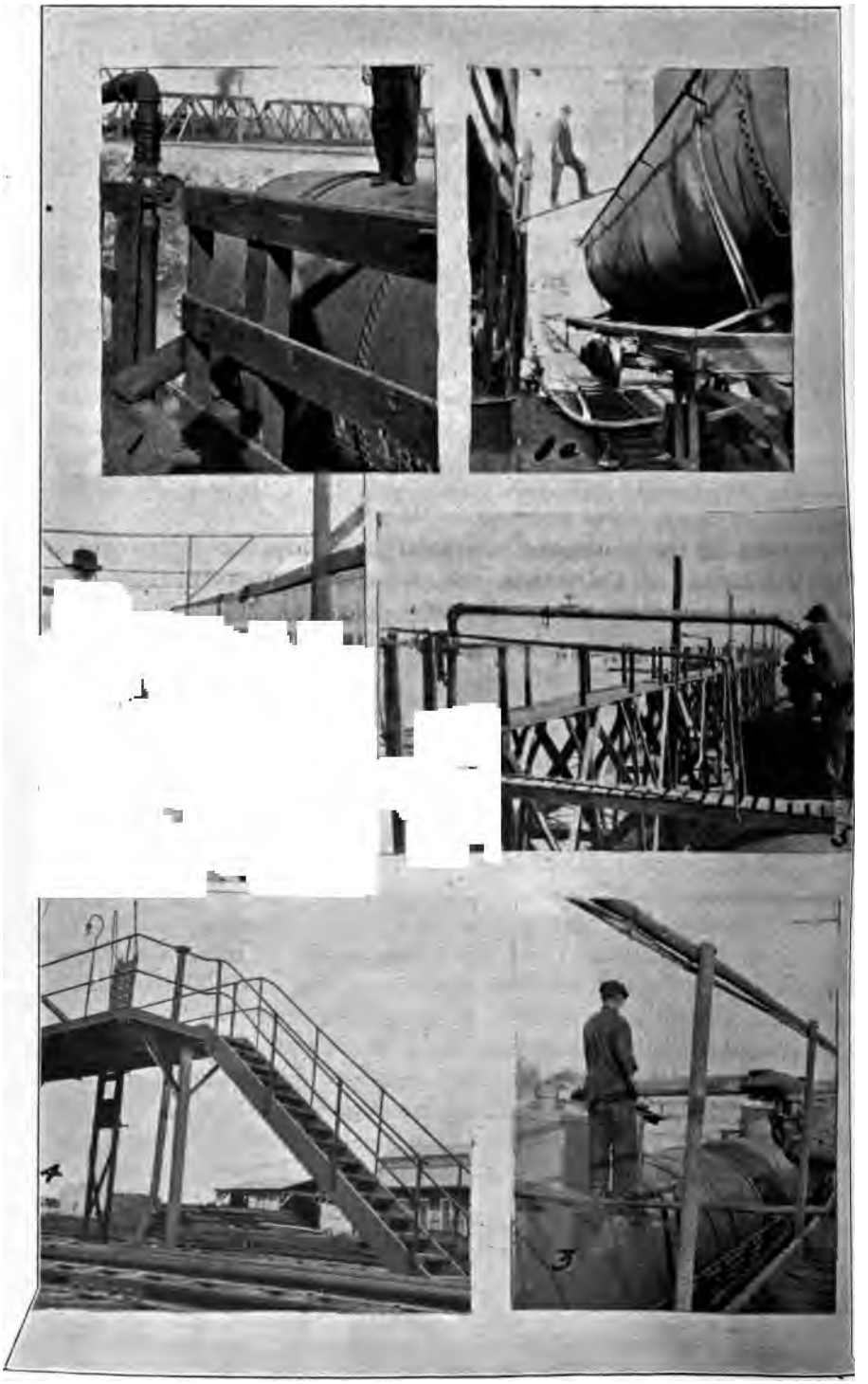
By WILL J. FRENCH, Chairman California Industrial Accident Commission.

A request to write an introductory page for the Petroleum Safety Bulletin gives opportunity for only a comparatively few sentences on a subject of vast importance to employers and employees. The records of the Industrial Accident Commission show that for the four years 1917-1920, inclusive, 82 men lost their lives in California while at work in the oil industry, 342 suffered permanent injuries of varying degrees, and 23,164 sustained temporary injuries. These figures will tell a story of an indelible character to each thoughtful person, and the high purpose of preventing such waste of life and limb that dominates the California Industrial Accident Commission needs the support of all citizens.

In welcoming the movement to extend the accident prevention gospel into the oilfields of California, the Commission desires to point out that it is actuated by the motive of helpfulness. We want to save precious human life. Needless mutilation should be stopped. The large number of temporary injuries imply the potentialities where death and crippling sometimes enter. These are by far the most important words that can appear on a page like this.

Employers will profit by a reduction of deaths and injuries. A saving in compensation payments means a financial benefit. The labor turn-over consequent on men forced to leave their jobs, either permanently or temporarily, is not only a detriment to business, but is costly in the extreme.

The Industrial Accident Commission advocates reasonable safety. It believes in a committee of employers and employees in each industry preparing safety standards, with the co-operation of the Commission's engineers. Home-made guards, proper inspection, shop committees, eternal vigilance all along the line, and a determination that Carlessness and Negligence "shall not pass," will remove the reproach pointed out in the first paragraph. The Commission pledges all its facilities to those engaged in producing oil in California, to the end that homes may be kept intact and sorrow and destitution lessened in the community.



LOADING RACKS.*

Railings.

In plates 1, 4, 6 and 7, railings are of suitable design, except that in the case of plate 6, a toeboard should be installed.

Railing in plate 5 should be equipped with a midrail and toeboard. The hand rails shown in plates 2 and 3 are typical installations of one of the oil companies. The rails are placed from 4½ to 6 feet above the rack platform; it being the practice that a man grasps the rail with one hand while swinging the loading spout to and from the car dome with the other. This single handrail is not considered sufficient to the need.

PLATE 6.

Gang Planks.

The loose gangplank shown in plates 1 and 1-A rests against a cleat nailed to the rack platform, is set at a high angle and made slippery by he presence of oil on the surface thereof.

In the foreground of plate 2 is a loose gangplank in a condition hich is a menace to the life and limb of workmen attempting to cross n same between rack and car. Planks used for this purpose have requently been found in a like poor condition.

In plate 3 is shown a loose gangplank, one inch thick, and with earing on rack none too secure. In general, loose gangplanks are ubject to criticism when considered from a point of safe practice.

*Article written by T. W. Osgood for *California Safety News*.

In plates 4 and 5, the weight counterbalanced gangways in use by companies, are of similar design.

The gangplank shown in plate 6 is of wooden construction, an easily lowered and raised by hand without the aid of a counterbala

The gangplank noted in plate 7 is of steel construction, and is sp counterbalanced by mechanism indicated by arrows.

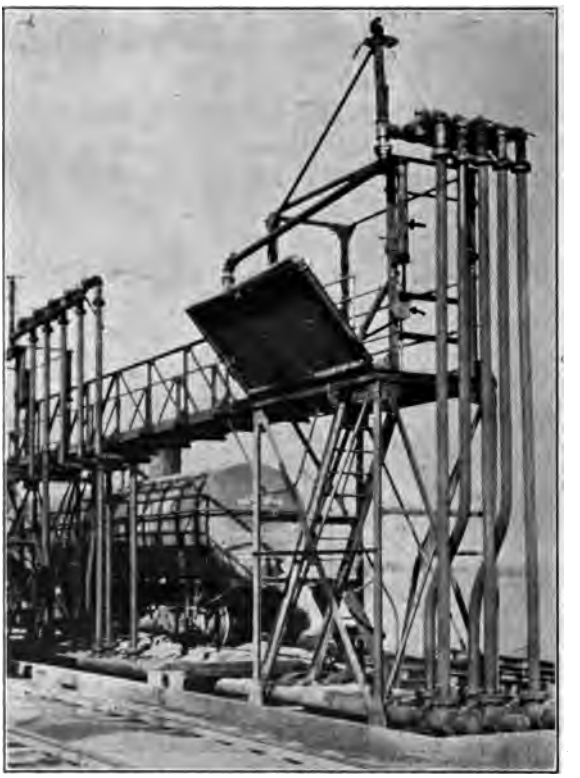


PLATE 7.

Gangplanks per plates 4, 5, 6 and 7 are functioning satisfact and are of suitable design, such that afford reasonable safety to using them.

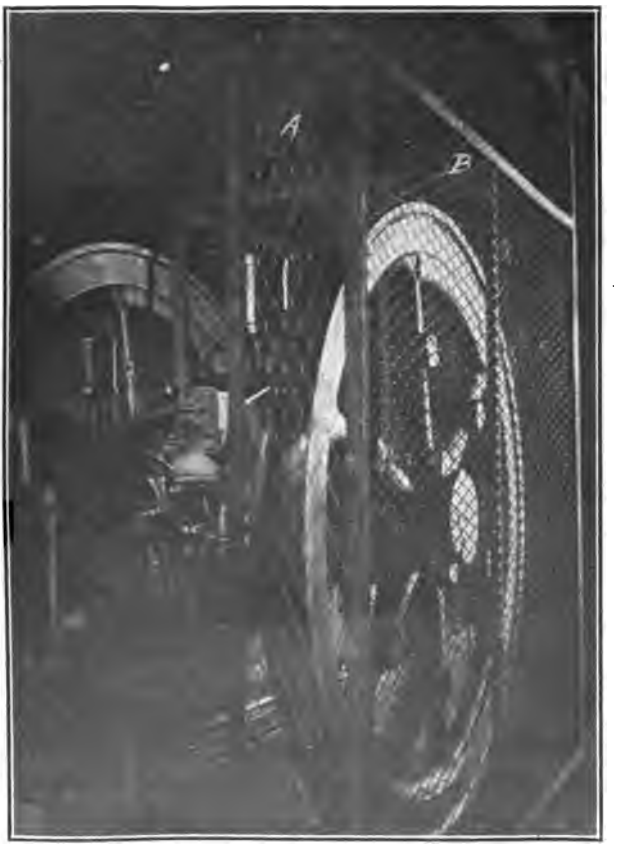
Stairways.

The stairway in plate 4 is of good design and construction. A s handrail on each side, in lieu of the two-rail railings, would be acc as sufficient.

Riser Pipes and Swing Pipes.

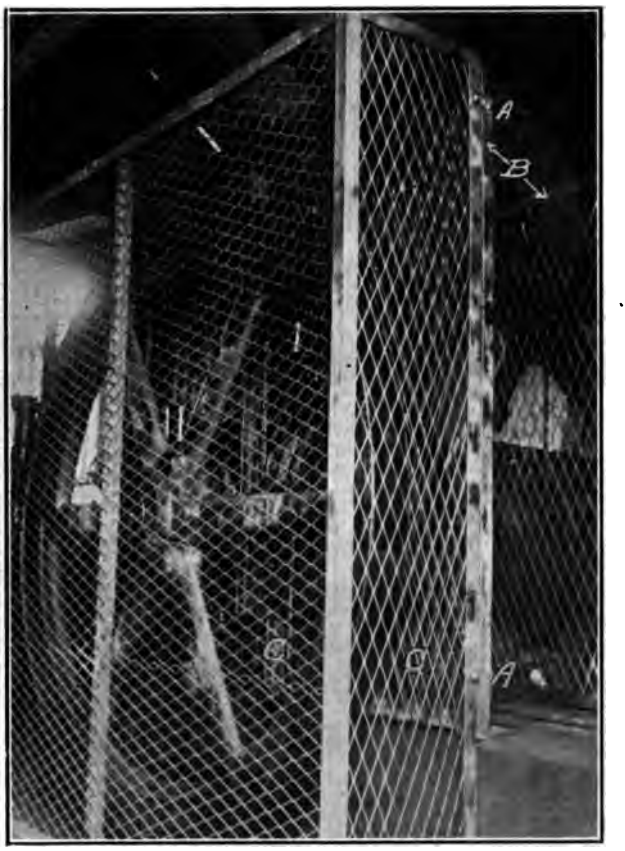
An excellent arrangement of riser pipes and swing pipes is shov *plate 7. Note the* single swing pipe manifolded to several supply *In plate 2, risers* and swing pipes are satisfactorily located.

ENGINE FLYWHEEL GUARDS.



Removable metal guard for pumping well gasoline engine flywheel. A and B slide on two overhead pipes to side of engine house.

Removable metal guard for pumping well gasoline engine flywheel. Showing guard A-B slid to side of engine room on overhead pipe runners (one of them shown at "C") so that man can get at flywheel to start the engine. D, E and F are permanent guards for inner sides of flywheels.



Pumping well gasoline engine flywheel guards, showing method of fastening removable guard C and C to permanent guard B by hooks at A-A.

Pumping well gasoline engine drive pulley, clutch and centrifugal pump pulley and belt guard rail.

Belt house runway and guard rail.

Welded iron guard over the band wheel shaft end and belt house runway with guard rail.

*Unguarded steam and gas engine flywheels are among the most glaring hazards immediately apparent to one visiting or inspecting drilling and pumping wells of the petroleum industry.

Engine Safety Order 107 of the Industrial Accident Commission, effective August 1, 1916, requires that all flywheels on stationary steam engines, gas engines, air compressors, electric generators and pumps must be guarded.

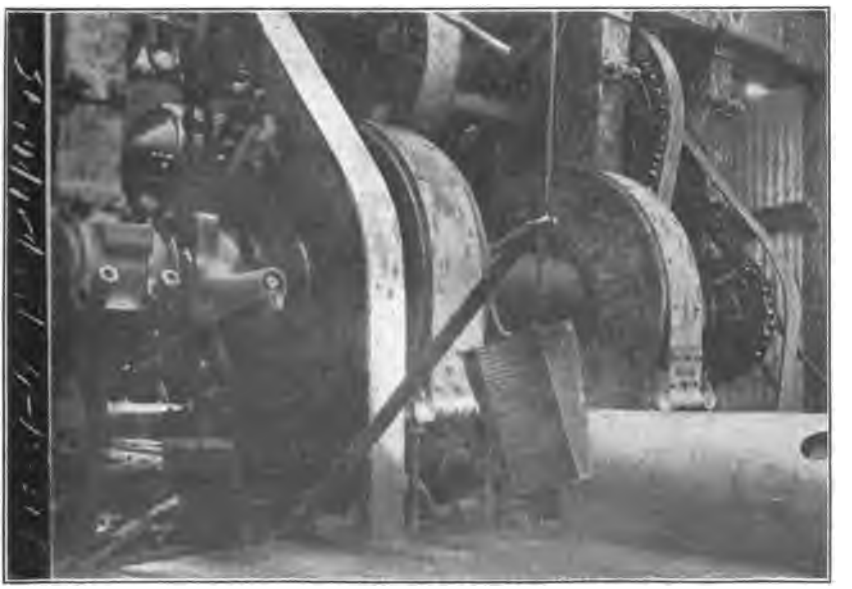
Unguarded flywheels have been the cause of a number of fatalities in the petroleum industry.

*Excerpt from article written by J. Wesley Gebb for *California Safety News.*

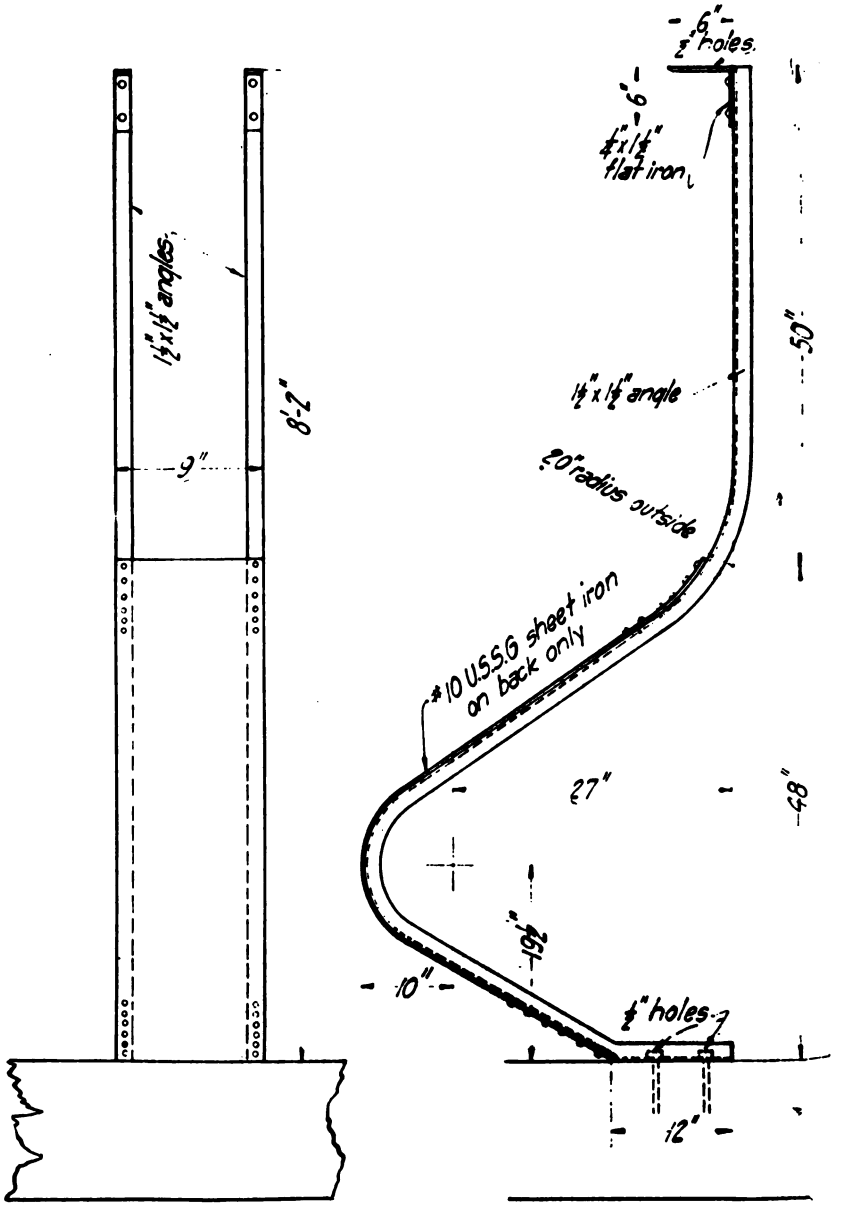
Guarded flywheels on a gas engine of a pumping well. These guards are of steel plate and angle iron construction.

Guards around sand reel, pitman and along walking beam of a pumping well.

Photograph showing pitman bearing grease cup piped out, which eliminates the danger in greasing pitman.

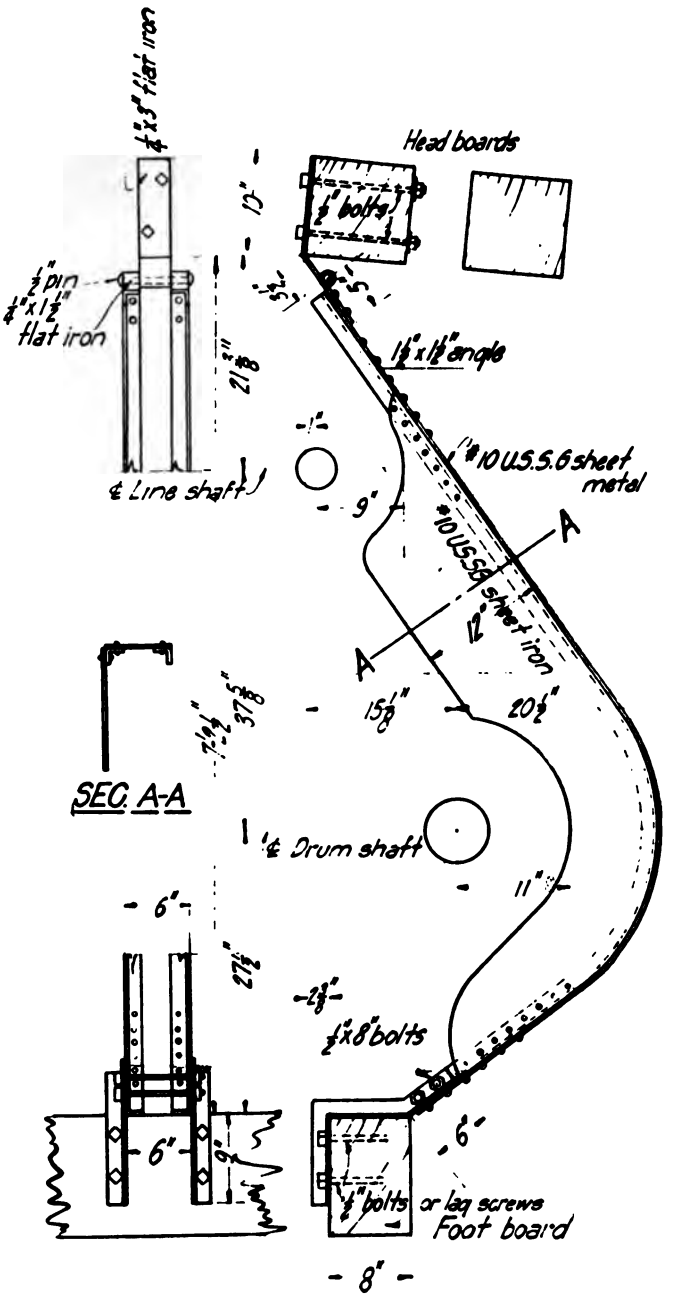


Photograph shows steel guards in place over the chains and gears of the drawworks of a shaft-driven rotary. Note that the guard over the hoist drum chain and sprocket next to the driller has a flanged side piece. This flange affords protection to the driller should the chain break and whip sideways. The band and flange are welded together into one substantial unit, making a job that fits in as a regular part of the machinery.



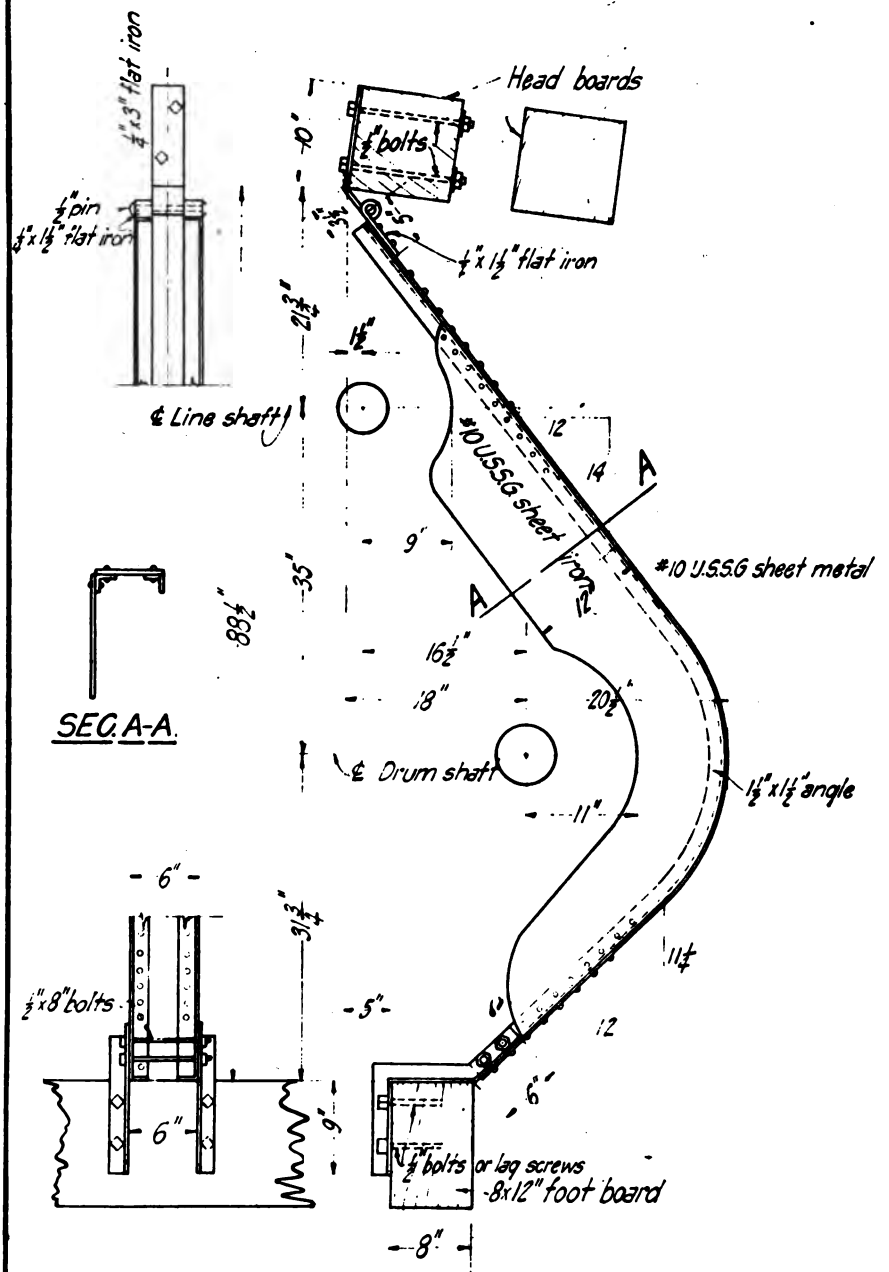
SPROCKET GUARD FOR TWIN CYLINDER IDEAL ENGINE

Designed by Shell Company of California.



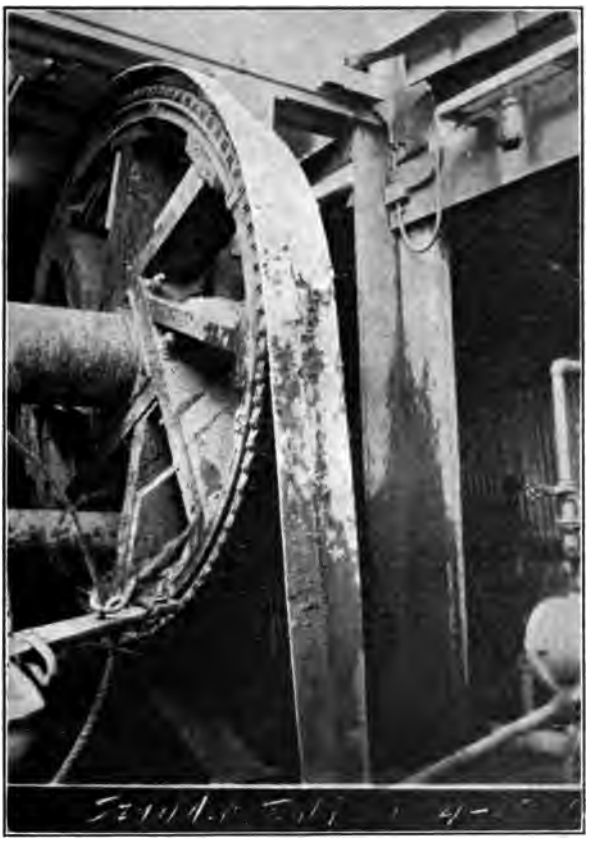
DRUM DRIVE CHAIN GUARD FOR No 3 ROTARY DRILLING RIG

Designed by Shell Company of California.



DRUM DRIVE CHAIN GUARD FOR NO. 5 ROTARY DRILLING RIG

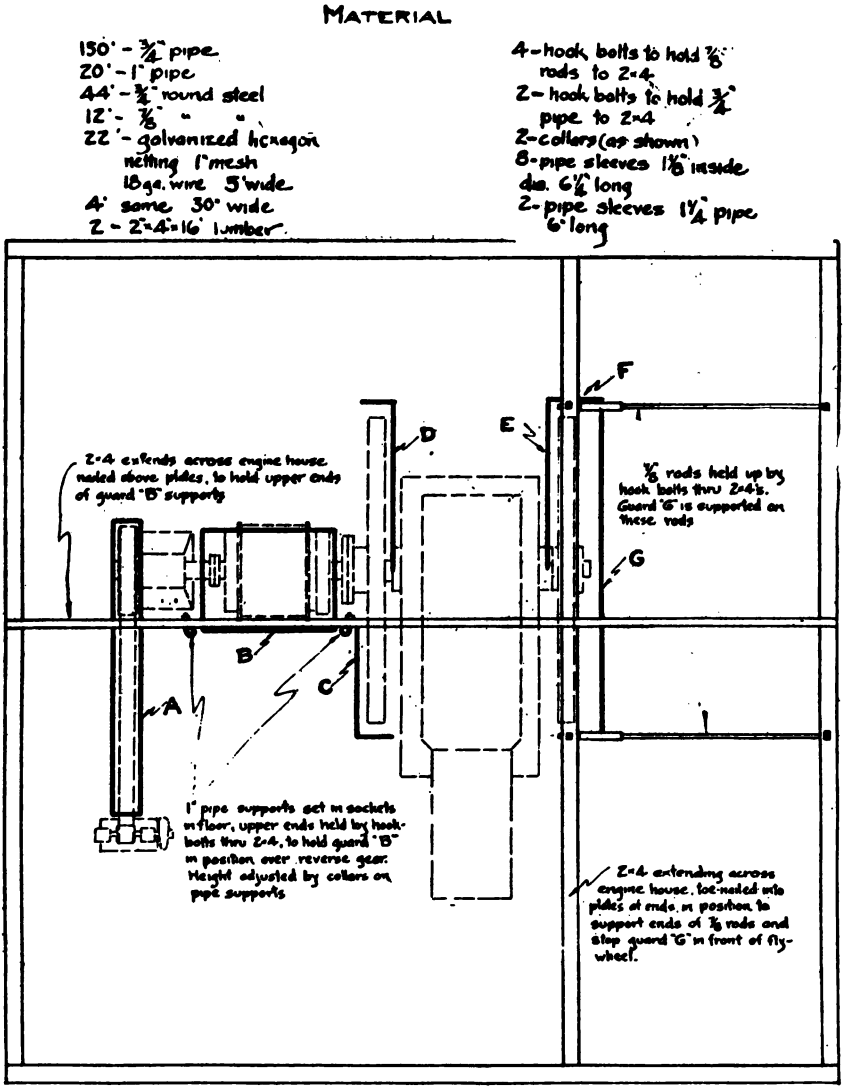
Designed by Shell Company of California.



Photograph showing a simple and effective steel band guard over the chain and sprocket tug ring of a calfwheel. Should the chain break, this guard will prevent the chain from kicking viciously in to the derrick floor area. This guard would be more effective if extended beneath the wheel.

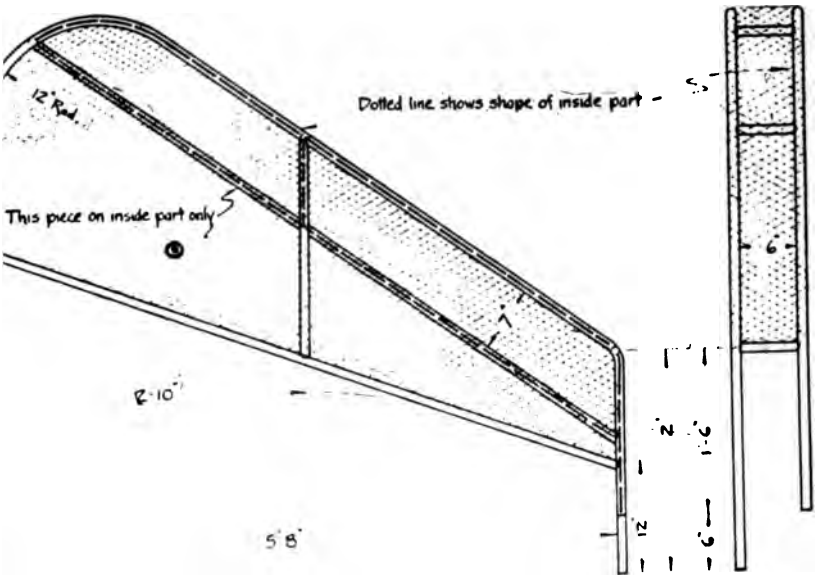
*Guards to be efficient must not only afford suitable protection but ust be practicable and substantial as well. They should be constructed as to appeal to the employee, so that he will learn to look upon them integral parts of the equipment that must be in place before operaons proceed, and that must go with the rig should it be moved to a w location.

*Excerpt from article written by J. Wesley Gebb for *California Safety News.*



SETTING UP PLAN

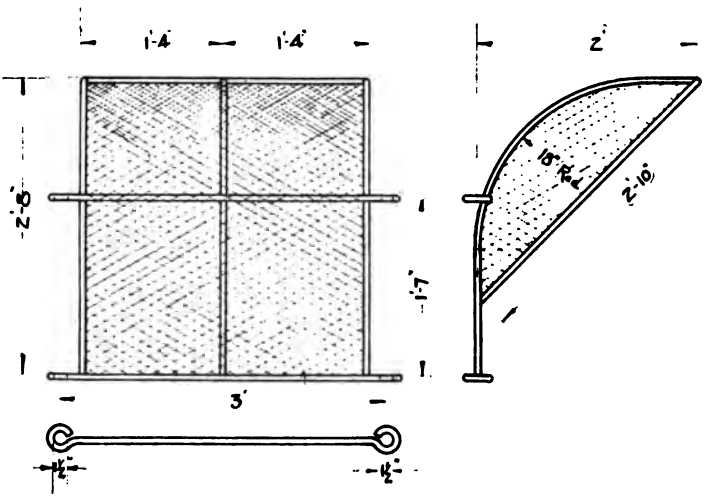
Guards for gas engines. Designed by Standard Oil Co.



PART A

Make of 3/4" pipe.

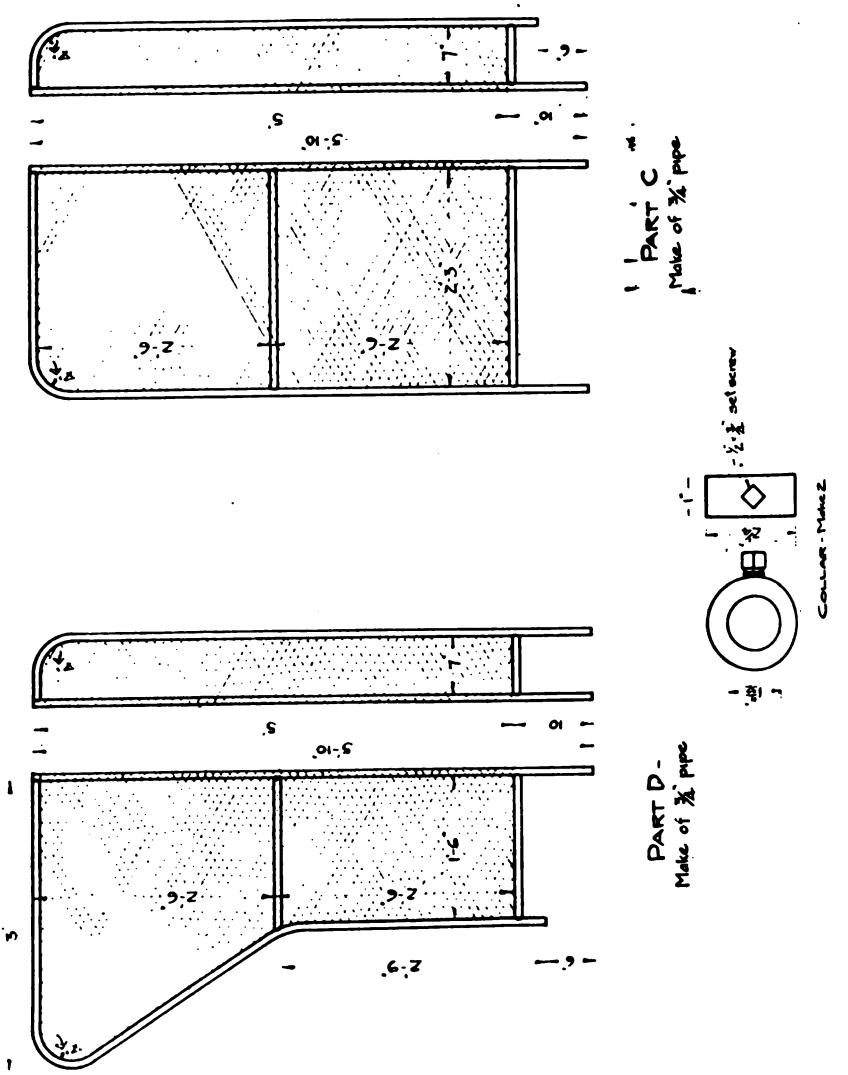
This part not needed for Superior



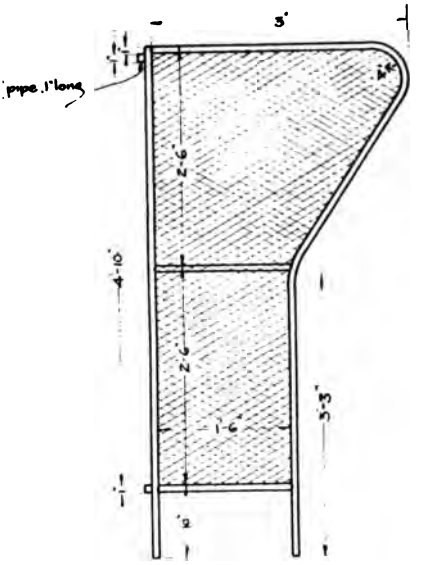
PART B

Make of 3/4" junk sucker rods

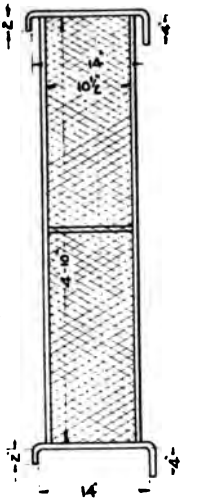
Guards for gas engines.



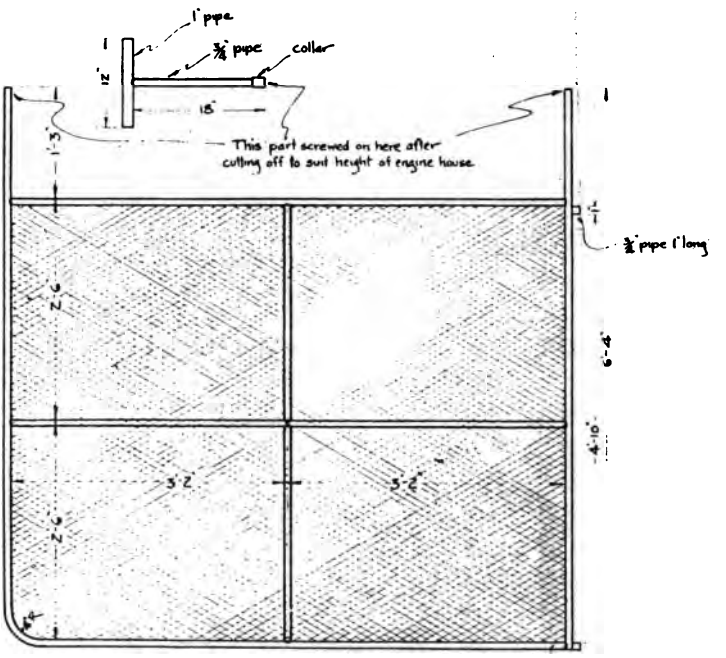
Guards for gas engines.



PART E
Make of ¾" pipe

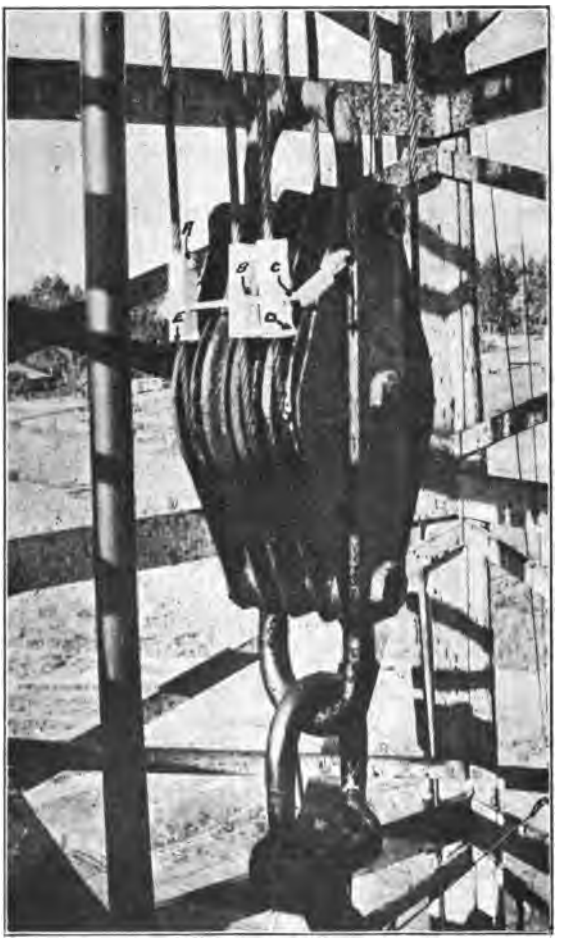


PART F
Make of ¾" junk sucker rods



PART G
Make of ¾" pipe

Guards for gas engines.



Cable and sheave-wheel guard adapted to traveling-block in oil derrick.

GUARD FOR CONTACT POINTS OF SHEAVE WHEELS AND CABLES.*

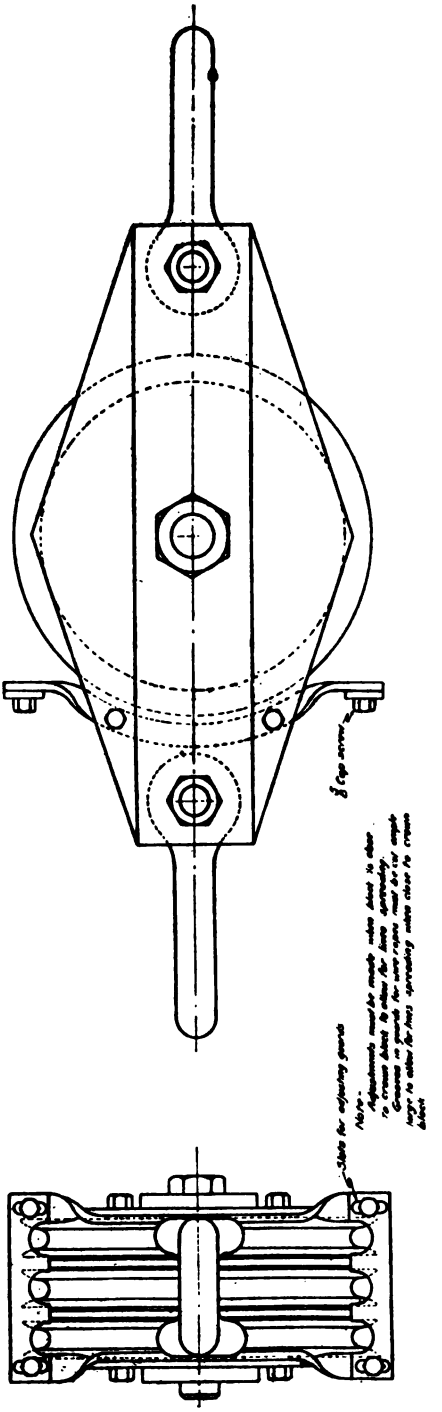
The cut clearly shows the guard in place. The bolts as at "A" and the rod "C" pass through pipe rollers inside the shoes; this to relieve friction on the cable.

The rod "C" passes through vertical oval slots in the shell of the shoes as at "B." These slots are of sufficient dimensions to permit free movement of the shoes in any direction.

The lower corners of the shoes, as at "D," are belled out and ride lightly against the flanges of the sheave wheels.

The upper and lower edges of the shoes, as at "E," are beveled out or away from the cable on the inside, to prevent the cable coming in contact with sharp edges of the shoes at those points. This type of guard is adaptable to any size block.

*Excerpt from article written by T. W. Osgood for *California Safety News*.



Safety guard for casing block. Designed by Pacific Oil Co.

GUARDS FOR SHAFT DRIVEN ROTARY DRILLING EQUIPMENT.*

"A" indicates the relative position of rotary drive chain for chain driven rotary. "B" shows a shaft bearing and "C" metal guards, completely housing revolving parts.

From the viewpoints of safety and of not obstructing operations in the derrick, the advantage of the shaft drive over the chain drive immediately becomes apparent, for the drive shaft can be easily guarded.

In case of the chain driven rotary, the chain extends centrally one-half way across the derrick floor. Due to location, weight, high operating speed, susceptibility to breakage and impracticability of adequate guarding, this piece of mechanism is an obstruction and a menace to the men when engaged in drilling operations.

*Excerpt from article written by T. W. Osgood for *California Safety News.*

DERRICK PLATFORMS.*

Derrick platforms should be guarded by two-rail railings, three and e-half (3½) feet high, with toeboards six (6) inches in height; the :boards prevent tools and material, carelessly left lying loose on the ıtforms, from falling upon workmen below.

Substantial platforms at frequent intervals on this derrick, as shown in the photograph, provide greater safety for employees.

Platforms at intervals of not more than thirty-two (32) feet, meas-ed vertically, should be provided. The corner posts of platforms ɔuld be made secure by extending braces from the bottoms of the ıter posts to the tops of the corner posts, and by braces extending ross the upper rails at the corner posts.

Strips of one-inch by four-inch (1″x4″) sound lumber should be stened over the ends of the ladder rungs of a derrick, or two-strand isted wires used so that the rungs can not be pulled off.

*Article written by J. Wesley Gebb for *California Safety News.*

SKIN INFECTIONS AND BURNS FROM DISTILLATE.*

Distillate is widely used in the oil fields and in shops for cleaning tools, pipe, and machinery. It is also a common practice to use it for washing the hands and arms when they become covered with crude oil or grease. Men who constantly use distillate for such purposes sometimes suffer from serious skin infections and from distillate "burns."

So-called distillate burns or blisters are of relatively frequent occurrence. These are usually caused by the clothing becoming saturated with the distillate and coming in contact with the skin. Skin infections or sores resembling boils are also often encountered. These sometimes become spread over a considerable area and are very painful and difficult to cure. Such cases usually begin on the backs of the hands or the wrists and arms. They first appear as blackheads, later surrounded by blotches due to inflammation. Unless the cause is removed, these blackheads develop into pimples and later into serious sores.

Unless preventive measures are taken, men who are working with heavy crudes or who wash their hands frequently in dirty distillate, gradually get the pores of the skin plugged. The pores become filled with grease, dirt, asphalt, paraffin, and other matter carried by the distillate or coming from the oil or other substances in which they work. Unless these pores are fully opened by frequent washing, bacteria begin to grow in the plugged pores. Bacteria are always present on the skin and in the air, so that infection does not necessarily come from the distillate in which one washes his hands.

Another cause of infection may come from the skin being scratched by metal particles, grit, and splinters carried in the oil or held in the oily waste with which the hands are cleansed.

Still another cause comes from rapid evaporation of the distillate from the skin. This allows the skin to grow hard and dry and it later becomes chapped. Bacteria then enter through the cracks in the skin and produce the painful results described above.

Persons whose skin is especially hairy are more frequently subject to such skin diseases than others. This is because the hair roots produce a greater number of pores or openings in the skin, thus giving greater opportunity for soreness to begin.

Contrary to a very common belief, infections of this kind are never caused by sulphuric acid contained in the distillate. Distillate manufactured under present conditions never contains sulphuric acid. All free acid is neutralized before the distillate is marketed. However, some distillates, as well as certain oils, do contain combined organic compounds resulting from sulphuric acid treatment, called sulphonates. These sulphonates are irritating to the skin, and under certain conditions may help to produce dangerous skin conditions.

*Published by permission of Roy W. Kelly, manager Industrial Relations Department, Associated Oil Company. Mr. Kelly wishes to asknowledge the valuable assistance given by numerous superintendents, both in the Associated Oil Company and in other companies. Suggestions were also made by other member companies of the National Safety Council. Valuable information was derived from the Safe Practices Pamphlet No. 44 of the National Safety Council, and from the report of the Houghton Research Staff, entitled "Causes of Skin Sores and Boils Among Metal Workers."

Prevention of Skin Troubles.

The first step in the prevention of these skin troubles is to use the proper grade of distillate. Some years ago it was customary in the oil fields to use a cheap grade of stove distillate for cleaning purposes. On some divisions nearly every one who used this distillate was subject to serious skin troubles. It was also found that it took nearly twice as much of the cheap grade of distillate to do the work as was required of a better grade of engine distillate. The distillate used can be either the brown or white distillate of good grade, approximating 35° to 45° gravity.

A particularly bad practice is the use of a common can of distillate in which several employees constantly wash their hands. This tends to spread infections from one to another. The oil quickly becomes filthy and tends to plug up the pores of the skin rather than cleanse it. A very much better practice is to provide a bottle or can of distillate so arranged that in washing the hands only a small quantity is poured out into the palms of the hands or used in a washbasin. Anyone who has camped in the desert, where water must be conserved, has learned to wash by pouring a small quantity of water over the hands. Distillate can be saved in the same way. Where several workmen use the same can for washing, the distillate soon becomes dirty and a gallon or more may be thrown away at a time.

Thorough washing several times daily with hot water and soap is perhaps the best possible preventive. Wherever possible, hot water and soap should be applied immediately after washing the skin with distillate. Where water is not available, the skin should be wiped dry with waste or a soft, clean cloth.

Particular care should be taken to change the clothing frequently. Underwear should be changed regularly at least once a week, and outer garments which become soaked with oil should be thoroughly cleaned at frequent intervals.

Experiments have been tried with disinfectants in the distillate. A small quantity of iodine will do no harm and tends to keep down the bacteria carried in dirty oil. It requires too much iodine, however, to render the distillate entirely sterile, and the use of disinfectants tends to careless disregard of other more important preventive measures. Disinfectants alone do not overcome all of the trouble.

Adding a small amount of cylinder oil or Cycol to the distillate tends to prevent rapid evaporation and chapping of the hands. Cycol, being free from sulpho compounds, is not irriating to the skin. Where this practice has been tried out, reports indicate that infections are seldom encountered, provided proper care is exercised by the workmen. Lard oil, vaseline, or carbolized cosmoline rubbed on the skin after washing tend to reduce the tendency of the skin to chap or break and serve as a partial preventive of infections.

The burns and blisters mentioned above can only be prevented by rigidly adhering to the rule that rags saturated with distillate should never be placed in the pockets. If clothing becomes wet with the distillate it should be changed at once or precautions taken to see that the saturated clothing does not come in contact with the skin.

Treatment.

Frequent washing with a mild soap and hot water may effect a cure of any slight infection. Dusting the arms with equal parts of zinc oxide and starch is also an effective remedy. Workmen handling distillate or oils should give prompt attention to all slight cuts or abrasions of the skin. Dressings placed on the cuts or wounds should be changed frequently if the work is such as to allow them to become saturated with distillate or oil.

USE OF GOGGLES ESPECIALLY IN PETROLEUM INDUSTRY.*

Goggles should be worn by men when doing the following work:

1. Chipping castings.
2. Turning brass steel shafting, etc.
3. Machining high speed steel.
4. Grinding on emery wheels.
5. Sand blasting.
6. Pouring molten metal or babbitt.
7. Oxy-acetylene welding or cutting.
8. Cutting rivet heads.
9. Handling acids or oils where there is danger of spilling or spattering.
10. Metal buffing and polishing.
11. Cutting steel cables, sand lines and other similar materials where wickers or particles may cause eye injuries. (To apply only to shops, including field shops.)
12. Dressing tools, where there is danger from flying scale.
13. Welding or other blacksmithing, where there is intense heat and light, or danger from flying scale.
14. Using compressed air paint spray.

Standard Style of Goggles.

Some employers recommend the Hardy welding goggle, equipped with No. 3 shade lense, for cutting, blacksmithing, etc.; the Wilson goggle No. 130 for emery wheel, boiler inspection and other work where a light, easily adjustable goggle is required.

Precautions in the Care of Goggles.

Each man should have his individual goggles for his own use alone.

Goggles should be kept in a case or box for use at the emery wheel.

Goggles should be frequently washed with soap and water and dipped in a sterilizing solution at intervals. This prevents the transmission of eye infections or diseases.

Regular inspections of goggles should be made by the foreman, who should insist upon their being kept clean and in good condition.

Glycerine pencils will tend to prevent the goggle lenses from fogging. Castile soap rubbed on the lenses and wiped off gently will also prevent *fogging of the* lenses.

*Information obtained from Roy W. Kelly, of Associated Oil Company.

Foreman must give the men a great deal of encouragement in order that they will use the goggles provided for them, and must also make a practice of inspecting the goggles at regular intervals to ascertain if they are in good shape and properly cleaned.

SAFETY ORGANIZATION.

The successful safety organization depends to a large extent on the interest shown by the chief executive and his assistants. The executive officer must first win the support of those directing the work before he can expect to obtain the cooperation of the men.

The outlines for safety organization as submitted below have been adopted by the California Inspection Rating Bureau.

Outline Class A—1 to 150 employees, inclusive.

Organization (Class A).

(*a*) A GENERAL COMMITTEE of not less than three (3) persons shall be selected from the following: Manager, superintendent, engineer, master mechanic, foreman or other employee in a position of authority, and shall:

I. Review and approve inspection reports.
II. Pass on all recommendations to determine their practicability. For this purpose, *meetings shall be held at intervals of not more than one* (1) *month*, and written records of such meetings shall be kept.
III. Familiarize themselves with the cause of all accidents, for the purpose of devising methods, which shall tend to eliminate similar accidents.
IV. See that new employees are properly instructed as to the hazard of their work, and that employees of the different departments are educated in safety practices, through the use of bulletins, printed rules or oral instructions.
V. Supervise the safety inspection work.

Inspection Service (Class A).

SAFETY INSPECTOR. There shall be a competent person in charge of inspection service, who shall make *regular weekly* inspections of the plant. Such person shall fill out and sign weekly reports, showing conditions of the plant and recommendations for changes. Standard blanks for inspection reports shall be furnished by the insurance carrier.

The general committee or safety inspector in charge of safety shall:

I. Follow up general lines of outstanding safety work and record same.
II. Make or arrange for regular inspections of special equipment, such as elevators, cranes, engine and motor stops, etc., and shall keep written records of such inspections.
III. Look after fire conditions, extinguishers, filling of fire (water and sand) pails, and keeping exits clear.
IV. See that drawings and specifications for new machinery cover the guarding of dangerous features, such as gears, sprockets and couplings. Inspect new machinery before it is placed in operation and see that necessary safeguards are provided.

Education (Class A).

(*a*) BULLETIN BOARD. Suitably located bulletin boards shall be provided, on which safety bulletins (which shall be changed at least monthly) and safety orders, rules and information shall be posted.

(*b*) A record of accidents shall be kept by preserving duplicates of reports on standard forms supplied by the insurance carrier.

Rules.

Recommendations at a given plant shall be *numbered consecutively from one* (1) *up*, stating:

I. The number of new recommendations submitted for the quarter.
II. The number of recommendations carried out.
III. The number of uncompleted recommendations outstanding at that time.

Outline Class B—151 to 500 employees, inc

Organization (Class B).

(*a*) A GENERAL COMMITTEE of not less than three (3) persons shall be selected om the following: Manager, superintendent, engineer, master mechanic, foreman other employee in a position of authority, and shall:

I. Review and approve inspection reports.

II. Pass on all recommendations to determine their practicability. For this purpose, *meetings shall be held at intervals of not more than one month*, and written records of such meetings shall be kept.

III. Familiarize themselves with the cause of all accidents for the purpose of devising methods which shall tend to eliminate similar accidents.

IV. See that new employees are properly instructed as to the hazard of their work and that employees of the different departments are educated in safety practices, through the use of bulletins, printed rules or oral instructions.

V. Supervise the safety inspection work.

VI. See that drawings and specifications for new machinery cover the guarding of dangerous features, such as gears, sprockets and couplings. Inspect new machinery before it is placed in operation and see that necessary safeguards are provided.

(*b*) A WORKMEN'S COMMITTEE shall consist of not less than three (3) workmen. The personnel of the committee shall be changed at regular intervals, preferably by rotation, and shall:

I. *Make not less than one* (1) *thorough inspection of the plant each month*, and shall submit (to the general committee) written reports of recommendations for safeguarding or approved safety conditions which they consider desirable, which reports shall be signed by members of the committee.

II. Inspect for maintenance of safeguards, general order, and arrangement of materials, cleanliness and lighting.

III. Look after fire conditions, extinguishers, filling of fire (water and sand) pails, and keeping exits clear.

IV. Investigate and report on all accidents.

Inspection Service (Class B).

SAFETY INSPECTOR. There shall be a competent person in charge of inspection service, who shall make *regular weekly* inspections of the plant. Such person shall fill out and sign weekly reports, showing conditions of the plant and recommendations for changes. Standard blanks for inspection reports shall be furnished by th insurance carrier.

Education (Class B).

(*a*) BULLETIN BOARD. Suitably located bulletin boards shall be provided, which safety bulletins (which shall be changed at least monthly) and safety ord rules and information shall be posted.

(*b*) A record of accidents shall be kept by preserving duplicates of report standard forms supplied by the insurance carrier.

Rules.

Recommendations at a given plant shall be *numbered consecutively from on up*, stating:

I. The number of new recommendations submitted for the quarter.

II. The number of recommendations carried out.

III. The number of uncompleted recommendations outstanding at that time

Outline Class C—Over 500 employees.

Organization (Class C).

(*a*) A GENERAL COMMITTEE of not less than five (5) persons shall b from the following: Manager, superintendent, engineer, master mechanic, other employee in a position of authority, and shall:

I. Review and approve inspection reports.

II. Pass on all recommendations to determine their practicability. F pose, *meetings shall be held at intervals of not more than one* written records of such meetings shall be kept.

III. Familiarize themselves with the cause of all accidents, for th devising methods which shall tend to eliminate similar acciden

IV. See that new employees are properly instructed as to the hazard and that employees of the different departments are educ practices, through the use of bulletins, printed rules or oral i the safety inspection work.

MITTEE shall consist of at least five (5) fo of the committee shall be ch

intervals, preferably by rotation, and the committee shall make *one general inspection* of the plant at least *every three* (3) *months*, for the purpose of standardizing safety work throughout the plant, and shall submit written reports to the general committee.

(*c*) A WORKMEN'S COMMITTEE shall consist of not less than three (3) workmen. The personnel of the committee shall be changed at regular intervals, preferably by rotation, and shall:

I. Make not less than *one* (1) thorough *inspection* of the plant *each month*, and shall submit to the general committee written reports of the recommendations for safeguarding or approved safety conditions which they consider desirable, which reports shall be signed by members of the committee.

Inspection Service (Class C).

SAFETY INSPECTOR. There shall be a safety inspector, who shall make *regular weekly inspections* of the plant and shall keep a complete record thereof. Standard blanks for inspection reports shall be furnished by the insurance carrier. His duties shall be to:

I. Follow up general lines of outstanding safety work and keep records of same.
II. Make weekly inspections of the plant and machinery and make written recommendations for necessary safeguards or safety precautions.
III. Make, or arrange for, regular inspection of special equipment, such as elevators, cranes, engine and motor stops, etc., and shall keep written records of each inspection.
IV. Inspect for maintenance of safeguards, general order and arrangement of materials, clealiness and lighting.
V. Look after fire conditions, extinguishers, filling of fire (water and sand) pails. and keeping exits clear.
VI. Investigate and report all accidents.
VII. See that drawings and specifications for new machinery cover the guarding of dangerous features, such as gears, sprockets and couplings, and inspect new machinery before it is placed in operation and see that necessary safeguards have been provided.

Education (Class C).

(*a*) BULLETIN BOARD. Suitably located bulletin boards shall be provided throughout the plant, on which safety bulletins (which shall be changed at least monthly) and safety orders, rules and information shall be posted.

(*b*) A record of accidents shall be kept by preserving duplicates of reports on standard forms supplied by the insurance carrier.

Rules.

Recommendations at a given plant shall be *numbered consecutively from one* (1) *up*, stating:

I. The number of new recommendations submitted for the quarter.
II. The number of recommendations carried out.
III. The number of uncompleted recommendations outstanding at that time.

CONCLUSION.

By H. M. WOLFLIN, Superintendent of Safety.

It is the desire of the Industrial Accident Commission to be reasonable and to work in cooperation with employers and employees in its campaign to reduce injuries in the oil fields. The Petroleum Safety Orders have not been completed because of the need of a more detailed survey of the industry before making effective any special orders governing it, also because we have lacked the facilities to complete this survey more promptly. There are many safety orders that have been in effect for a number of years, that apply to operations in the oil fields, as well as to mining or quarrying or manufacturing enterprises, since many of the hazards are identical. On the other hand, there are a number of hazards that are peculiar to the oil industry and special requirements are necessary to eliminate them. Above all else these special require-

ments must be reasonable and practical and every effort will be exerted to make them so.

When the safety work in the oil fields was started for a second time about a year ago, it was found that neither employers nor employees had a thorough knowledge of the safety requirements already in existence, covering much of the equipment that they use. An effort has been made to inform the men in the field about these safety requirements, and, at the same time, to collect information on which could be based the special requirements applicable to the petroleum industry.

It is planned to reorganize the 1919 Petroleum Industry Safety Orders Committee and then to review and, if necessary, revise its recommendations. This work will be commenced shortly after the issuance of the Petroleum Safety Bulletin. When the tentative orders have been completed by the committee, they will be printed and distributed for the criticisms and suggestions of the persons interested. If a large number of changes are suggested, it is possible that the tentative orders will be reprinted and distributed before a public hearing is held. Thus it is hoped that the result will be a set of reasonable safety standards that are thoroughly practical and workable, because formulated largely by the employers and employees in the oil industry. After the widest possible opportunity has been given to those interested to suggest changes, public hearings will be held for further discussion of the proposed orders, after which the Industrial Accident Commission will issue General Petroleum Safety Orders.

As the engineers of the Industrial Accident Commission have visited the oil fields in various sections of the state, they have noticed that while the greatest precautions are taken to prevent injuries to workmen in some fields, slight protection is afforded in other fields. In a number of instances they have observed efforts to protect men against injuries that were made at considerable expense and inconvenience, with a result that was entirely unsatisfactory; but if the men who made these efforts had seen the work done in other fields, or had known of the methods adopted for guarding equipment in other districts in the state, full protection could have been obtained with the expenditure of less money.

Frequently it has been found that the lack of protection arises primarily out of lack of knowledge of safety standards for the equipment in use. This is only natural when the attention of those in charge is focused primarily on production. If the foremen and superintendents from each field could visit all the other fields, many of the dangerous conditions and dangerous practices that are now in existence would disappear without friction or delay, but this course is manifestly impossible. It would appear that the next best thing is to supply the officials in each field with the standards that observation has shown afford the best protection to the workmen. This is what will be attempted to a limited extent in the General Petroleum Safety Orders.

In connection with our efforts to spread information about existing safety requirements and to secure compliance with those requirements, as well as to formulate the few additional standards that are needed, the Industrial Accident Commission desires to be conservative. It will accord a full hearing to any appeals that are made from requirements *or decisions of* field men when there is disagreement.

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